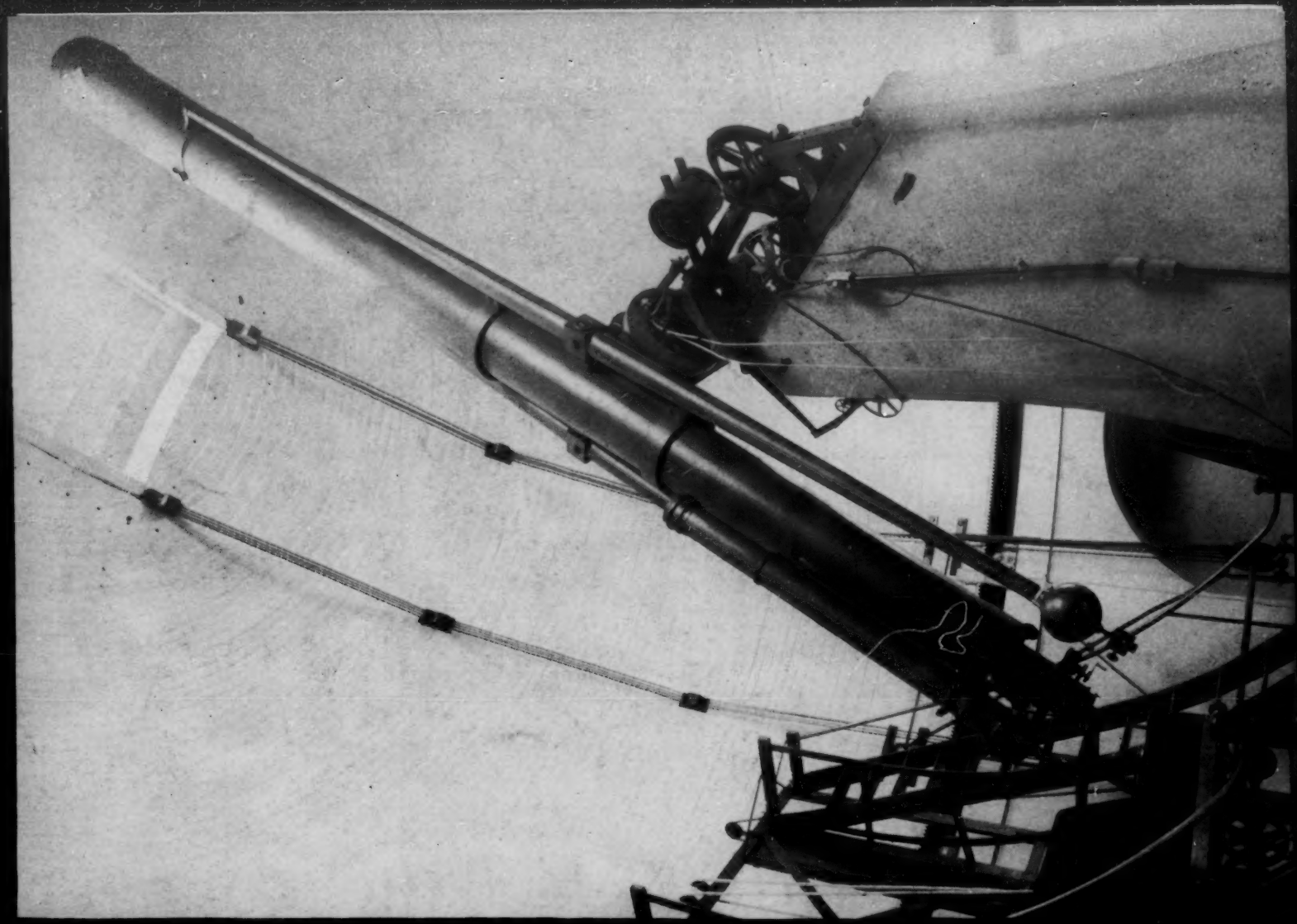

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Sky and TELESCOPE

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The Editors Note . . .

ROADS for amateur astronomers lead to Philadelphia early next month, where on the weekend of July 4th will be held the fifth national convention of amateur astronomers and the first convention sessions of the newly formed Amateur Astronomers League (see page 12). Everyone interested in astronomy is invited to attend and to take part in the varied program, whether or not he is a member of one of the 30 societies which have joined the League.

Conventions such as the one in Philadelphia should soon be occurring frequently in many parts of the United States, fostered, presumably, by the regional organizations which are to be formed within the Amateur Astronomers League. League memberships now extend from Maine to Oregon, and from California to Florida.

As the chief purpose of any convention is to foster activity in the field of interest concerned, there will naturally be considerable discussion of the present status of amateur astronomy in this country. The editors would like to present at the convention an up-to-date list of organized amateur societies in the United States. Already such a list is compiled, and it appears in this magazine occasionally under the heading Here and There with Amateurs. But it is known to be incomplete, both because some societies have not informed us of their current active state and because of the formation of new groups.

If your society, or one of which you are aware, was not listed in Here and There with Amateurs in our March issue, please let us know at once. Also, we would like to hear of organizational plans for clubs which have just begun activities or contemplate doing so in the fall. It is probable that the total number of amateur astronomy groups in this country, exclusive of those in secondary schools, will reach 100 in the near future.

As for unaffiliated individual amateurs, especially those in rural areas, their numbers run into thousands. We look forward to the provision by the League for membership directly by individuals. These amateurs will then have a part to play in the growth of organized amateur astronomy and astronomy education, even though they have no opportunity to join in the activities of local groups.

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Stars for June 22

BACK COVER: A portion of the moon near last quarter, from a Lick Observatory photograph taken with the 36-inch refractor by J. H. Moore and J. F. Chappell. This is Plate XV in the series. (See In Focus.)

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The dome of the 15-inch telescope as it appears today. The small dome on the right houses a 6-inch refractor. Photo by Paul Southwick.

THE GREAT REFRACTOR

By Leon Campbell, *Pickering Memorial Astronomer*
Harvard College Observatory

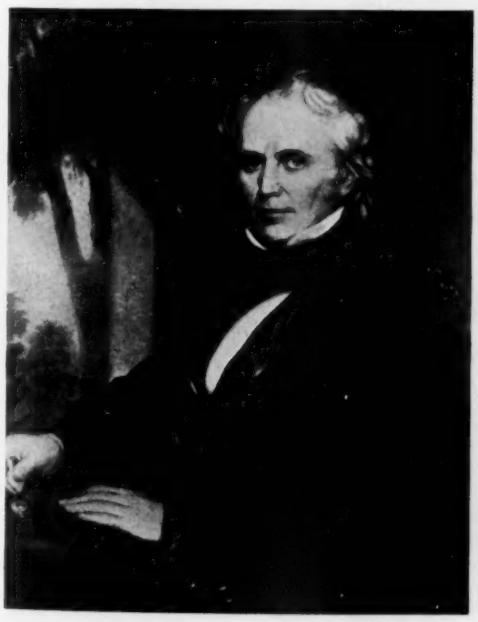
ATOP THE HIGHEST CREST in Cambridge, Mass., about a mile from the Harvard campus, in a large weathered-green dome, majestically stands the Great Refractor of Harvard, apparently little the worse for wear for the hundred years it has surmounted its massive granite pier.

For a century it has stood ready to be turned toward the heavens to view whatever might present itself for observation, whether a spectacular object, or something of a more routine nature. The story of the Great Refractor seems worthy of being told, especially now that June 23, 1947, marks the 100th anniversary of the night it was first pointed to the sky.

Born of a comet, so to speak, its erection may be said to mark the establishment of Harvard Observatory as one of the great astronomical institutions of the world. To be sure, Harvard had in 1839 set up a modest observatory at Dana House on the campus, under the direction of William Cranch Bond, but it took the Comet of 1843 to give the impetus to fulfill the hopes and aspirations for a really large observatory.

With the sudden appearance of this brilliant daylight comet in March of that year, and with no sizable telescope to study it in detail, much interest was aroused in the vicinity of Cambridge and Boston among scientific societies and astronomically minded individuals in the plan to erect a telescope comparable in size to the largest in Europe, and equal, or better, in quality to the best at that time in use anywhere.

With the announcement by the Honorable David Sears that he would contribute $5,000 to the cost of the dome to house such a telescope if the necessary funds were subscribed to purchase the instrument, it did not take long to secure the $20,000 needed for the project.



William Cranch Bond, first director of Harvard College Observatory.

Accordingly, after consultation with some of the most eminent practical astronomers of Europe, it was decided to order from the famous instrument makers, Merz and Mahler of Munich, Germany, a 15-inch refractor, complete and ready to be installed at the new site in Cambridge. The contract called for the making of two objectives, the university to have the right to take its choice.

While the lenses were being made, the buildings on the new site were erected, including the dome to house the Great Refractor. To support the telescope, a central base was built with a foundation 20 feet below the surface of the ground, on which was erected the pier itself, made of huge blocks of Quincy granite. The pier is circular, tapering from a diameter of 22 feet at the base to 10 feet at the top. Upon this stands a granite pedestal 11 feet in height, weighing 11 tons, to the top of which is attached the equatorial mounting of the telescope. The pedestal itself rests on three bearings, allowing of easy readjustment of the telescope in case the necessity should arise. During the past half century, at least, no readjustment has been required.

The central building which supports the dome is square on the outside, but of circular form on the inside. The ground floor contains what is known as the rotunda; around the pier which stands in the center are built bookcase stacks, and on the walls there are still more bookcase shelves.

In the dome above, reached by a winding staircase, are recesses in three corners, one serving as a recording alcove, another as a depository for observing accessories, and the third for the machinery which is used to rotate the 12-ton copper-covered dome. In the old days, the turning of the dome was accomplished manually, a large spoked wheel geared to a track at the base of the dome being turned by the observer and his assistant. The dome rested on eight cannon balls which moved in a smooth track. In more recent years the cannon balls were replaced by trucks, and an electric motor now does the work of the two men in rotating the dome. Seven of the cannon balls went into service as war material during the recent conflict; the eighth is preserved as a souvenir of the old days.

The dome has an inside diameter of about 30 feet. In order that the instrument may be pointed to any desired portion of the heavens, a slit in the dome is provided which is five feet wide, and consists of two large movable sections and three smaller shutters. With such an arrangement one has available an observing arc reaching from three degrees beyond the zenith to the horizon, and by rotating the dome through a complete circle, in either direction, a sweep of the entire visible sky.

A large tablet on the south wall of the observing chamber lists the names of the individuals and societies who contributed to the original cost of the Great Refractor. An observing chair, capable of being moved on tracks about the floor of the dome, and of being lowered or elevated by hand to accom-

These are reproductions of some of the earliest astronomical photographs ever made, taken with the 15-inch refractor. The naked-eye double star, Mizar (series of exposures), Saturn, and the moon were suitable photographic subjects.

modate the observer at any position of the eye end of the telescope, is provided. It was the invention of the first director, William Cranch Bond.

The great lens was selected in the summer of 1846, and reached Cambridge that December. The effective aperture of the lens is 14.95 inches, and its solar focus is 22 feet, six inches. In June of 1847, the telescope tube and equatorial mount arrived, and it took but a few days to set up the instrument on its pier. The tube itself is made of light wood and paper, strengthened by iron diaphragms, and covered on the outside with a veneering of mahogany. To prevent flexure in such a long tube, there are attached two round conical brass rods 17 feet in length, with large spherical weights, eight inches in diameter, at the ends. A finder of three inches diameter was first supplied, but through the years this was replaced by a 4-inch telescope, and still later by a 5-inch instrument. Sidereal motion is conveyed to the instrument by means of clockwork, originally weight driven, but now run by electric motor. The original finely divided circles were later augmented by large coarsely marked circles which can be read directly from the floor or eye end of the telescope.

Naturally, the first object to be viewed was the moon, and an examination with high- and low-power oculars revealed a faultless image, and showed details in surface markings previously unsuspected. The Great Nebula in Andromeda and the Orion nebula next came under close scrutiny, both yielding details hitherto impossible of detection. The Orion nebula became an object of special interest and study in those early years, not only in the details of its whorls, but in the observation of the individual stars therein. Harvard's first variable star, T Orionis, enmeshed in the depths of the nebula and not far from the Trapezium, is still, after nearly a century of observation, being assiduously followed by many variable star observers in this country and abroad.

From the outset, once the telescope was ready for use, many visitors were privileged to have a "peek" through the glass. Great things had been expected of the Great Refractor, and neither the public nor the astronomers were disappointed. The definition was perfect, especially in those days when the atmosphere of Cambridge was more-or-less free of smoke and haze, and city lights did not bother, as they do today.

Of course the two Bonds, William Cranch and his son George P., were the first to put the telescope to its test, and it is difficult at this late date to differentiate between the work of the two famous observers; they were in-

Some members of Harvard's present-day staff view the plaque in the 15-inch observing chamber on which are listed the names of the original contributors. At left, Associate Directors Bart J. Bok and Donald H. Menzel; at right, Director Harlow Shapley. Photo by Paul Southwick.

Left: An early drawing of the Orion nebula made by George P. Bond, with the aid of the 15-inch telescope.

Right: Donati's comet on October 5, 1858, as drawn by George P. Bond. When the head of the comet passed over Arcturus, which is close to the comet in this drawing, the star was visible through the comet.

separable as far as most of their research was concerned.* Between them they studied the planet Saturn, then ideally placed for observation. In 1848, they were co-discoverers of the eighth satellite of the planet, and in 1850 of Saturn's delicate inner ring, known as the crape ring. They were also fortunate in being able to detect the so-called divisions between the rings themselves. Charles W. Tuttle and Sydney Coolidge, as astronomical assistants to the Bonds, also played an active part in the study of this planet.

Comets came under observation to a marked extent, George P. Bond having discovered at least eight, and Tuttle several others. It is remarkable that during those early years many brilliant and spectacular comets came into view. Most famous of all, without doubt, was Donati's of 1858, and George P. Bond's monograph, containing many elaborate drawings and diagrams of the physical appearance of the head and tail, has been called an astronomical classic, especially since it was made before the days of advanced celestial photography.

The Bonds, as mentioned before, made a special study of the Orion nebula, their drawings recording most remarkable features, second only to later astronomical photographs.

Other early work with the 15-inch refractor included the determination of the positions of faint stars in a one-degree zone near the celestial equator, and photometric measures of the satellites of the several planets. Still later, under the third director, Professor Joseph Winlock, assisted by Benjamin Pierce, Charles S. Pierce, Samuel P. Langley, and George M. Searle, many micrometer measures were made of these same satellites. Double stars came in for their share of attention, separations as small as one third of a second of arc being possible under best observing conditions.

*Textbooks and other authorities are not in agreement in crediting one or the other of the Bonds for their various discoveries. — ED.

High on Observatory Hill, the dome of the Great Refractor dominated the early scene in Cambridge.

Probably the event of most far-reaching effect on Harvard Observatory and on astronomy as a whole was the taking of the first stellar photograph by George P. Bond in 1850, with the volunteer assistance of Messrs. Whipple and Black, professional photographers of Boston. Although the Great Refractor was in no sense a photographic instrument, it is this telescope that has the distinction of having taken the first picture of a star. The star was Vega in the constellation of Lyra, and a wet daguerreotype plate was used with an exposure of several minutes, as compared with the fraction of a second which is possible today with improved lenses and plates. Only the lack of a more refined clock drive probably prevented further advance in this work in the early '50's. In the words of the Bonds, "we were encouraged to hope that the way is opening for further progress. If it should prove successful when applied to stars less brilliant than Alpha Lyrae, so as to give correct pictures of double and multiple stars, the advantage would be incalculable." How little did these pioneers in astronomical photography foresee to what limits we would go in the years to come!

During the '70's, the observatory was fortunate to have had the services of a French artist, E. Leopold Trouvelot, whose drawings of the planets, comets, the sun and moon, as observed in the Great Refractor, were gems of artistry and accuracy.

With the coming of Director Edward C. Pickering to the observatory, the Great Refractor was put to work on extensive photometric projects, particularly in connection with the determina-

tion of the magnitudes of both variable and non-variable stars. In this work he was assisted first by Arthur Searle, Frank Waldo, and Oliver C. Wendell. Later Professor Wendell had complete charge of the work with the 15-inch for over 25 years, measuring photometrically the disappearances and reappearances of Jupiter's satellites as they went in and out of eclipse. These observations covered three revolutions of Jupiter and proved of inestimable value in later correcting the elements of the four brightest satellites. Wendell also devoted many observing hours to measuring the light variations of eclipsing variables, deriving light curves which proved fundamental material in the study of orbits of these special stars.

Early in the 20th century, with the installation of Harvard's 12-inch polar telescope, where the observer could carry on photometric observations with all the comforts of home — a warm room in winter, and mosquito-free in summer — the use of the Great Refractor on large programs of visual work began to diminish. Now, photographic methods at Harvard have rather eclipsed visual observations, except in rare cases, so much so that in recent years the 15-inch has been used mainly to satisfy the curiosity of the public. Through the planning of Director Harlow Shapley, thousands of visitors on open nights at the observatory have been privileged, not only to gaze upon the instrument itself and to learn a bit of its history, but to look through it at such objects as the moon, Saturn with its wonderful rings and surface colorings, Jupiter and its ever-interesting belts and bright moons, and the galactic and non-galactic nebulae.

In spite of the increasingly poor observing conditions to be found in Cambridge, which have necessitated moving most of the telescopic equipment to the Oak Ridge station at Harvard, Mass., some 26 miles distant, the Great Refractor still stands as a monument of the days gone by, yet ready, when the occasion arises, to perform its noble work of revealing to the human eye the wonders of the universe. Much larger telescopes have made their appearance since the days of the Bonds, but for optical perfection, Harvard's famous 15-inch still remains a Great Refractor.

Navigation Notes

Institute of Navigation Eastern Region Meets

THE EASTERN REGIONAL MEETING of the Institute of Navigation was held at Harvard University on April 18th and 19th, when 21 papers covered navigation "from the rowboat to the rocket."

One afternoon session was devoted entirely to consideration of instrument approach and landing systems. D. F. Folland described the Sperry microwave system with which not only "hooded" but hundreds of fully automatic landings have been made. This system, incorporating technical progress made during the war, appeared to be much superior to the lower-frequency CAA-ILS equipment now being installed wherever possible.

A gyro-stabilized camera that is being employed with shoran for precision aerial mapping was described by Dr. Roy C. Gunter, of Boston University. By means of shoran, microwave distance-measuring equipment, the position of the aircraft can be determined within a few feet up to ranges of 250 miles from the ground responders. As the camera axis is held within 10 minutes of arc of the vertical by the newly developed controls, while the actual height of the aircraft can be determined simultaneously with a radar altimeter, latitudes and longitudes for ground points can be derived with considerable precision from a series of overlapping photographs. Adaptation of war-born devices to the surveying of large uncharted areas — a sizable part of the United States is only poorly mapped — will soon permit large-scale mapping to be carried on rapidly at costs far below those of routine triangulations.

The morning session on April 19th was concerned with the teaching of navigation. Dr. Bart J. Bok, of Harvard College Observatory, discussed the place of navigation in the college curriculum. He concluded that navigation should not be thought of as equivalent to a good course in one of the more fundamental sciences, but rather that it is useful as a "second science," where the student may apply and integrate information and concepts obtained in previous courses.

Julien M. Christensen, of the Aero Medical Laboratory, Wright Field, told of the navigation aptitude tests developed by the Army Air Forces. After a careful study of the duties of navigators, certain critical operations, both physical and mental, were isolated. By pre-testing on these operations, candidates could be rated as to their chances of completing the training. Those "most likely to succeed" according to the tests ran only three chances in 100 of failing, but less promising candidates ran nearly a 50-50 chance of "washing out." Such tests allowed maximum efficiency in the utilization of man power.

A set of three-star position tables has been devised by J. K. de Jonge, graduate student at Harvard and recently a lieutenant in the Netherlands East Indies Air Force. With these tables, the most probable position of the aircraft can be found directly in latitude and longitude within less than five minutes after the completion of celestial observations. Lines of position are not involved, but the tables are built from consideration of the intersections of the three planes which cut the earth to form on its surface the well-known circles of equal altitude.

The concluding paper was "The Control of Missiles — An Advanced Problem in Navigation," by Dr. A. C. Hall, of Massachusetts Institute of Technology. He considered briefly three possible methods of control as applicable to long-range missiles traveling several thousands of miles. All terrestrial controls, including radio aids, seemed to him inadequate. The ballistic approach, employed in all cannon and rifle fire and used for the German V-2 rockets, requires exceedingly high-precision internal control gear. The pendulous gyro employed in the V-2 as an integrating accelerometer to establish the velocity at which the fuel is cut off was described, but with the added comment that for long-range flights comparable equipment must be a thousand times more precise.

For missiles flying slower and within the atmosphere some type of automatic celestial guidance seems desirable. While automatic star-tracking equipment of the type employed on telescopes could be used, the principal problem lies in devising some kind of stable platform to be used as an artificial horizon. Dr. Hall concluded by noting the great difficulties involved in obtaining the necessary precision of automatic control through the application of known physical principles, yet unhappily wondering whether these difficuities might not be overcome before the complicated snarls of international diplomacy and cooperation were unraveled. Let us hope that international morality and goodwill win over science.

FLETCHER G. WATSON
Harvard University

METEORITICAL SOCIETY AND AAAS MEET TOGETHER

The 10th meeting of the Meteoritical Society will be held on June 18th and 19th in connection with the meeting of the Pacific division of the American Association for the Advancement of Science in San Diego, Cal. Headquarters for the meetings will be the U. S. Grant Hotel. The afternoon session of June 19th will be held jointly with the Astronomical Society of the Pacific. Information concerning hotel accommodations and the like may be obtained from the chairman of the local general committee, R. Dana Russell, Navy Electronics Laboratory, San Diego, Cal.

Members of the Pacific division of the American Association for the Advancement of Science will visit Mount Palomar as a part of the activities planned for the 28th annual meeting, to be held in San Diego from June 16th to 21st.

BOUND VOLUMES

of Sky and Telescope are now available, for Volumes II, IV, and V, at $6.00 each, plus postage. Binding is in blue library buckram, and the index is bound in each volume. Indexes to all volumes are still in stock, at 35 cents each, in stamps or coin.

SKY PUBLISHING CORPORATION

NEWS NOTES

By Dorrit Hoffleit

TABLES ON THE UPPER ATMOSPHERE

With the advent of jet propulsion and rocket flights, studies of the upper atmosphere have acquired a purely practical in addition to their usual scientific interest. The National Advisory Committee for Aeronautics has tentatively extended its tables of the "standard atmosphere" from 65,000 to 400,000 feet above the earth's surface. Such tables are necessary for computations involving the prediction of aircraft performance. The older tables gave values for temperatures, densities, and pressures and their ratios relative to sea-level values. The new tables give additional information, including the velocity of sound. They are based on various types of data, including those derived from observations of meteors and the aurora.

The variations of temperature with altitude are especially interesting. From a standard value of 59° Fahrenheit at sea level, the temperature falls to 67 degrees below zero at seven miles, remains as low up to 20 miles where it begins to increase, reaching the torrid temperature of 170° at 30 miles. At 40 miles it begins to drop again, to −27° at 50 miles. Higher up the temperature rises again. It appears that the ozone layers, which absorb most of the ultraviolet radiation from the sun, are responsible for the first rise in temperature, and the radio-reflecting E-layer causes the increase above the 50-mile level.

It is important to note, however, that above about 20 miles the temperature-density values become increasingly uncertain. Seasonal variations, short-period variations, and latitude effects have not yet been determined for the upper atmosphere. It is gratifying, however, to find that upper atmosphere meteorological data telemetered from V-2 rockets confirm the general picture previously obtained from computations pieced together from many sources.

SUNSPOTS IN THE NEWS

The sun, its spots in particular, is at present one of the most profusely studied heavenly bodies, both by amateur and professional astronomers. At the spring meeting of the American Association of Variable Star Observers, at Hood College on May 17th, the exceptionally enthusiastic and active solar division planned the presentation of several papers on sunspots. Its chairman, Neal J. Heines, prepared a bulletin in April summarizing current sunspot literature; any amateur interested in studying sunspots should consult this bulletin. (Mr. Heines' address is 560 Broadway, Paterson, N. J.) In *Popular Astronomy* for March, there appears an excellent resume on "Sunspot Problems Old and New," by R. S. Richardson, of Mount Wilson Observatory, and in the *Griffith Observer,* April, 1947, there is a useful table of solar data as well as excellent photographs and an account of the sun for laymen.

According to a Science Service release dated April 25th, the current sunspot maximum will be reached this August, if the calculations of Dr. A. G. McNish and Miss J. Virginia Lincoln, of the Central Radio Propagation Laboratory, National Bureau of Standards, are correct. Full details of their method of prediction were given at the meeting of the Terrestrial Magnetism and Electricity section of the American Geophysical Union on April 29th.

Mr. McNish and Miss Lincoln have developed a chart based on all previous 11-year sunspot cycles, from which they believe accurate predictions can be made a full year ahead from observations for the preceding year.

VAN GENT DIES

Word has been received of the death of H. van Gent, head of the Johannesburg station of the Leiden Observatory, while he was attending a meeting of the South African Association at Amsterdam. Dr. van Gent was particularly well known for his work on variable stars, as well as for his collection of astronomical photographs from which he made important investigations on Milky Way structure. Three comets which he discovered bear his name. He was only 47 years of age.

ALASKAN CRATER

During the war, Dr. Lincoln La Paz, of the Institute of Meteoritics, University of New Mexico, serving as technical director of the Operations Analysis Section, Headquarters, Second Air Force, encouraged flyers to be on the lookout for possible new meteorite craters. In a recent issue of *Popular Astronomy,* Dr. La Paz summarizes the efforts and discusses the reasons for the meager results. The one most promising new find was made by an infantryman, and not by an aviator. While on duty in the Aleutians in 1943, Charles Keenan, brother of the astronomer, P. C. Keenan, found on the island of Amak a crater roughly 70 yards across and 50 feet deep.

The finder states the crater was so close to the water's edge that by now erosion has probably reached its rim; hence Dr. La Paz is anxious to have additional on-the-spot information from anyone who has been or is going to Amak Island. Although Mr. Keenan's observations and description make it seem probable the crater is indeed meteoritic and not volcanic or some other geological formation, more definite conclusions might be reached had he been able to make a few excavations. The crater and surrounding terrain were thickly covered with frozen moss which would, of course, have covered any meteoritic fragments that might have been in the vicinity.

SIBERIAN METEORITE?

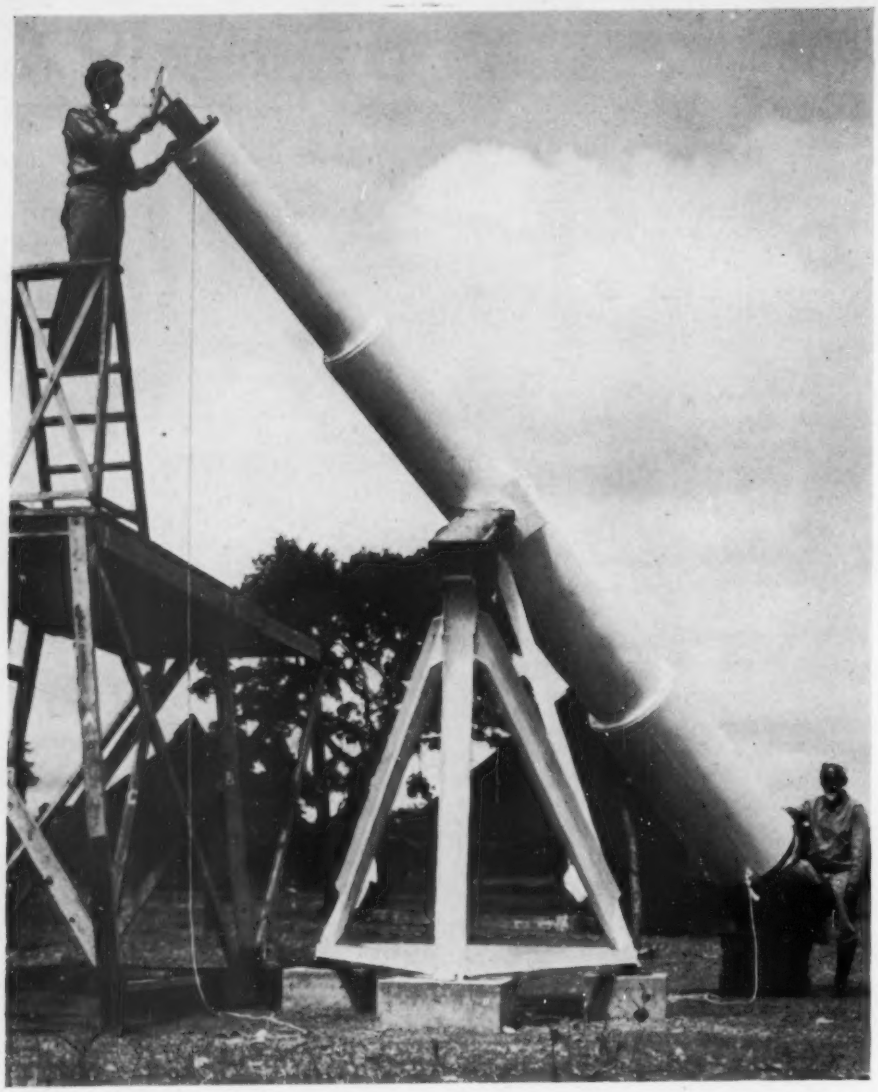
According to an Associated Press item a "missile" described as a meteorite fell in eastern Siberia on February 12th, this year. The report quotes V. G. Fesenkov, chairman of the meteorite committee of the U.S.S.R. Academy of Science, as saying, "It is now becoming increasingly clear that it was an exceptional phenomenon in many respects. For one thing some of the fragments smashed through the surface strata of soil and penetrated into bedrock, leaving several dozen craters, the biggest of them about 75 feet in diameter." The Russian astronomer thinks it was "quite possible that what happened in the Far East was the collision of a minor planet with the earth." A Soviet expedition is studying the area of the fall.

OBSERVERS WANTED

Weathermen across the country are preparing to study the habits and characteristics of thunderstorms, in order better to cope with such weather features as thunder, lightning, wind, turbulence, icing, rain, and hail. The Amateur Weathermen of America request the assistance of volunteer observers to report on thunderstorms that come within sight. It is hoped to have at least one such observer in each community. Proper forms will be supplied, and no special instruments are required other than a reasonably accurate watch and a good pair of eyes.

Amateur Weathermen will co-operate with three groups of professional meteorologists who are conducting intensive studies of thunderstorms in three sections of the country. In southern Ohio, the U. S. Weather Bureau and the University of Chicago will concentrate attention on the storms around Wilmington, just southeast of Dayton. New England thunderheads will be studied by radar by the Army Air Forces at Massachusetts Institute of Technology, and in New Jersey the Signal Corps at Fort Monmouth and the U. S. Navy at Lakehurst will conduct joint radar observations of all storms in the Middle Atlantic states.

All who would like to serve as volunteer thunderstorm observers should write: Thunder and Lightning, Amateur Weathermen of America, The Franklin Institute, Philadelphia 3, Pa.



This camera is operated by Dr. G. Van Biesbroeck and F. Oliver Westfall (on ladder) to measure the Einstein effect. Note the low inclination of the polar axis, which points to the south celestial pole slightly more than 17 degrees high. All illustrations in this article are copyright National Geographic Society.

BOCAYUVA BULLETIN

Preparations and program of observations at Bocayuva prior to the eclipse on May 20th

OBSERVATIONS carried on by the Army Air Forces-National Geographic Society eclipse expedition to Bocayuva, Brazil, have been said to constitute the most comprehensive study of a solar eclipse ever undertaken. The total personnel at the eclipse camp numbers about 80, half civilian, half military. Presumably, this includes the men of the staff of the National Broadcasting Company who are making short-wave broadcasts from the site before and during the eclipse. Their motion pictures are to be flown to New York and televised within 48 hours after totality.

Scientific leader of the expedition is Dr. Lyman J. Briggs, of the research committee of the National Geographic Society and retired director of the National Bureau of Standards. A synopsis of the observing projects indicates practically complete coverage of all the problems which may be studied at a total eclipse of the sun, and includes some important related investigations.

Coronal photography. To obtain photographs of the sun's outermost atmosphere in black-and-white and in color, Dr. Irvine C. Gardner and Leo W. Scott, of the National Bureau of Standards, are operating eclipse cameras. Their work will determine the shape, brightness, and extent of the corona, and will enable precise comparison with observations made at the same time by the coronagraphs at Climax and in Europe. The polarization of the corona is also being measured.

Flash and coronal spectra. Two spectrographs are being operated by Dr. Carl C. Kiess, National Bureau of Standards, and Dr. Harold F. Weaver, Lick Observatory. Such spectrograms enable astronomers to study the physical and chemical characteristics of the sun's reversing layer, chromosphere, and corona, with certain observational advantages not available without benefit of eclipse.

Crescent brightness. It is well known that the visible hemispheres of the sun and other stars suffer limb darkening caused by absorption of the outgoing radiation in the atmosphere of the star concerned. The rate at which the light of the diminishing solar crescent fades before totality begins and increases after totality can be used to determine a rate of limb darkening for the sun independent of other methods. This important check on the absorption coefficient of the sun's atmosphere is being conducted by Drs. Kiess and Weaver.

Contact times. With a short-focus camera, Drs. Francis J. Heyden and Laurence C. McHugh, both of Georgetown University Observatory, are making photographs designed to time the contacts — first contact, when the moon first encroaches on the sun and partial eclipse begins; second contact, when totality commences; third contact, the end of totality; and fourth contact, the end of the eclipse. Accurate timing of the contacts furnishes a check on predictions of the positions and motion of the moon, and may also be applied to geodetic determination of differences in longitude, provided similar observations are made at a distant point on the path of totality.

Milky Way photography. Every clear night before the eclipse, photographs of the southern Milky Way were taken by Drs. Heyden and McHugh, using the same camera as for timing the contacts, with exposures up to two hours and reaching stars some

Dr. Van Biesbroeck at the guiding eyepiece of the Einstein-effect camera. The large plate size is necessary to cover the large-scale field.

2,000 light-years distant. Here is a case of astronomers not wanting to miss an opportunity to add to our knowledge of a region of the galaxy which is beyond the reach of observatories situated in the Northern Hemisphere.

Einstein effect. One of the predictions of the theory of relativity is that light rays from a star are appreciably changed in direction when passing near a body as massive as the sun. Newtonian gravity also produces some displacement in a star's apparent position during an eclipse, but of only half the amount predicted by relativity. The apparent position of a star close to the sun's limb during totality should differ by about 1.75 seconds of arc from its place when far from the sun in the sky. Obviously, a total eclipse affords an opportunity to see the stars in the sun's vicinity, as normally the glare of the sky around the sun blots them out.

To make a new test of the Einstein prediction, the long-focus camera shown opposite is operated by Dr. G. Van Biesbroeck, of Yerkes Observatory, and F. Oliver Westfall, National Bureau of Standards. The resulting large-scale photographs of stars around the sun will be duplicated with the same camera from the same location at night in about six months. For this reason, the Einstein-effect camera has a very stable, heavy mounting, as it must remain undisturbed until the night pictures can be taken.

Astronomers at other eclipses have made the same test, with favorable results as far as verifying the Einstein effect is concerned, but Dr. Van Biesbroeck expects more accurate results than hitherto obtained. Differential refraction for stars at various altitudes and changes in the refraction of the atmosphere during the eclipse may introduce factors not fully allowed for previously. During this eclipse, Army Air Forces aircraft will record the temperature and pressure of the air at various altitudes, including those reached by sounding balloons going as high as 60,000 feet. These observations should enable a very accurate determination of the coefficient of refraction for every star near the sun.

To procure standard reference positions, on the same plates on which he photographs the star group near the sun Dr. Van Biesbroeck will record another group of stars at a position in the sky at right angles to the first group. Light from this second group will be unaffected by the Einstein effect. It will be reflected into the telescope tube by the half-silvered mirror situated at the top of the telescope tube (see picture).

The Einstein-effect camera has a focal length of 20 feet, and was built for the purpose at Yerkes. Its lens is specially corrected to focus red rays; therefore a red filter may be used to eliminate the strong green light from the corona during totality.

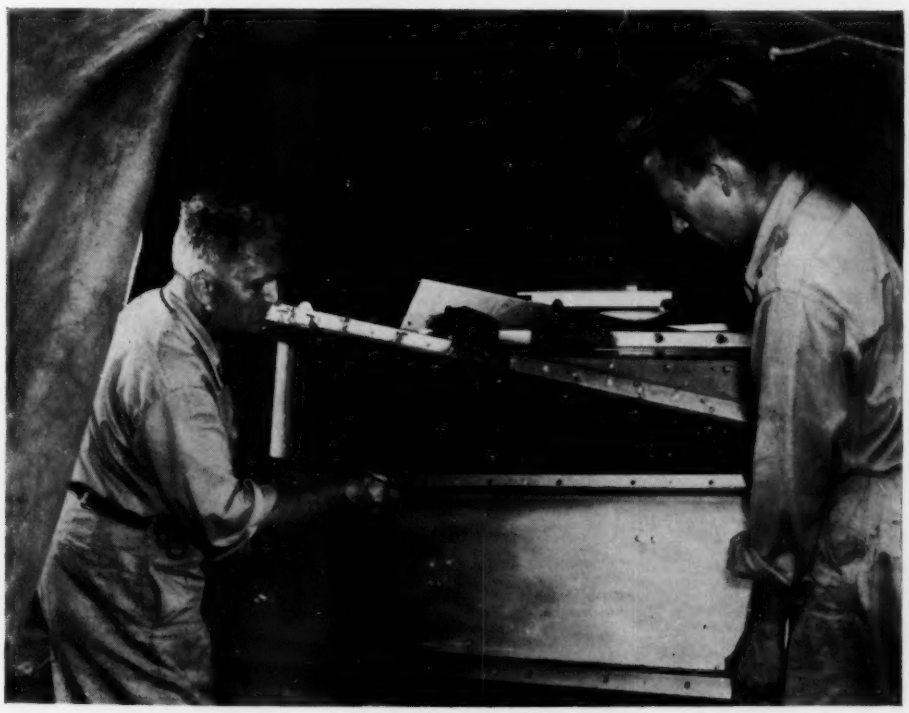
Ionospheric research. This project can be carried on during a solar eclipse whether or not the sky is clear. During totality, when the moon's shadow strikes the ionized layers of the upper atmosphere, these layers tend to change their electrical characteristics. Normally, radio energy is reflected from three principal layers: the E-layer, at altitudes of about 60 to 70 miles; the F_1, at 100 to 120 miles; and the F_2, at 150 to 250 miles. The moon's shadow, striking obliquely down upon the earth, first cuts out the E-layer over the eclipse observation site, then the F_1, and finally the F_2, although this layer may not be completely cut out. From the behavior of the radio echo, the amount and rate of recombination of the ionized particles in each layer can be determined.

Georgetown University astronomers (Dr. Heyden on ladder, and Dr. McHugh) and the camera for timing the contacts.

The ionospheric layers are formed by ultraviolet light, presumably from the sun itself, but possibly also from the solar corona, which emits some ultraviolet radiation. Just before the eclipse, the moon shuts off part of the corona before it covers the sun itself, and this occurs for another portion of the corona after totality is over. If radio signals reflected while the corona alone is covered show any reaction in the ionosphere, evidence of the role played by the corona's ultraviolet light may be procured.

Observations of the ionosphere, the first ever made at this latitude, were carried on for many days before the eclipse, and will continue afterward to furnish averaging data. Pulses are recorded every 15 minutes, but every 15 seconds on eclipse day.

The radio-sounding apparatus, operating on frequencies from one to 24 megacycles, is situated at the expedition's airplane landing strip 14 miles from the main camp in order to avoid interference with camp time-signal and other radio reception. A 72-foot antenna mast of plywood was flown in sections from the United States. James M. Watts and



Dr. Kiess (left) and Dr. Weaver with one of the spectrographs.

Franklin Kral, of the National Bureau of Standards, are conducting the ionospheric research.

Cosmic radiation. Geiger-counter apparatus specially built for the expedition is being operated by Peter A. Morris, Martin A. Pomerantz, and Harvey C. Taylor, all of the Bartol Research Foundation of the Franklin Institute. They especially wish to study the intensity of mesotrons in the Southern Hemisphere. Sounding balloons are carrying cosmic-ray apparatus to heights of about 20 miles, while a B-29 plane will carry Geiger counters sent down to Rio de Janeiro by ship. This B-29 is the same "flying laboratory" which collected important cosmic-ray data in flights last year from southern Canada to northern Chile.

Meteorological observations. Not only are complete weather records of importance to the eclipse observers and to the interpretation of their data, but this expedition furnishes an opportunity to make meteorological observations from a location not usually included in comprehensive records. Directed by Dr. Briggs and under the immediate supervision of Major William E. Walk, Jr., Army Air Force weather units of 18 men are making hourly surface weather observations around the clock. Four times a day they send up balloon-borne radiosonde and rawinsonde apparatus. These transmit back by radio the temperature, atmospheric pressure, and humidity of the upper air. Antennae such as are used in radar pick up signals that indicate wind direction and velocity. The rawinsonde balloons may be tracked by radio even when it is too cloudy to see them. A complete meteorological station was transported to Bocayuva by air. Weather observations began 30 days before the eclipse and are continuing for five days afterward. High-altitude observations by balloon and airplane during the eclipse will be employed by Dr. Van Biesbroeck in determining the value of atmospheric refraction for the stars around the sun.

Dr. E. O. Hulburt and Ralph A. Richardson, Naval Research Laboratory, are studying the distribution of daylight intensity at various altitudes during the eclipse, as well as the molecular density and temperature of the air up to 40 miles high, if possible.

Airplane observations. The Army Air Forces are operating a B-17 photographic plane to take pictures of the eclipse from 30,000 feet, insuring a record of the phenomenon even if low clouds should hamper ground observers. A wide-angle camera may record the passage of the moon's shadow across the earth. At Bocayuva, above which the plane is to fly, the shadow is about 256 kilometers long, 168 kilometers wide, and traveling northeastward more than one kilometer per second. Totality is scheduled as three minutes, 58 seconds long, but the motion of the plane can increase this interval by a good portion of a minute, depending on the speed and direction of flight.

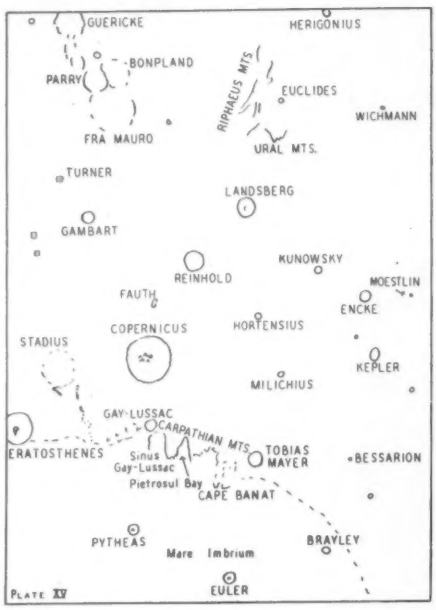
The shadow-photography project has been worked on by the Optical Research Laboratory of Boston University, and amateur astronomer Wagn Hargbol, of the Boston Telescope Makers, is one of the members of the scientific crew of the B-17.

General notes. The eclipse is being photographed in black-and-white and in color by Richard H. Stewart and his assistants on the staff of the National Geographic Society. Documentary color motion pictures of the eclipse and of eclipse camp preparations and activities will furnish a lasting record of this expedition. Most of the information contained in the foregoing account (prepared on May 12th) has been compiled from news bulletins issued by the National Geographic Society, and the pictures here reproduced are under National Geographic Society copyright.

In Focus

TWO of the most famous craters on the moon, and a variety of other mountain and crater formations, make this comparatively smooth region of considerable observing interest. This Plate XV adjoins last month's region to the north, and with Plate XVI farther to the north, the three complete one strip from south to north on the moon. Features on this month's back cover will also be found on Plates XI and XII, which appeared in February and March this year, and some of the features identified here will be found described in the In Focus columns for those months.

All named formations are shown on the accompanying key chart. Biographical information is from **Who's Who in the Moon,** a pamphlet issued by the historical section of the British Astronomical Association, and spellings and identifications follow the International Astronomical Union's **Named Lunar Formations,** by Blagg and Mueller.



Bessarion. Just a few miles in diameter, this crater and a similar one to its north stand on a bright area of the moon.

Bonpland. This and the nearby Fra Mauro are formations whose walls have apparently been almost completely eroded away. Bonpland was a French botanist who traveled with Humboldt in South America, collecting and exploring.

Carpathian Mts. This range on the south side of Mare Imbrium is over 125 miles long. It was named by Maedler.

Copernicus. Called by Goodacre the grandest of all the large crater rings on the moon, Copernicus has walls in places 12,000 feet high, terraced on the inside. There is a complex mountain in the interior. Copernicus is on a bright area, and bright rays extend in all directions. The terrestrial Copernicus hardly needs identification — Nicholas Copernicus, 1473-1543, whose sun-centered planetary system paved the way for the modern science of astronomy.

Fra Mauro. A 15th-century Venetian geographer gave his name to this formation. His map of the world, finished in 1457, was hung in 1910 in the Doge's palace in Venice. (See Bonpland, above.)

Gambart. This is a small crater with a smooth, rather dark interior. Jean Felix Gambart lived only from 1800 to 1836. He was director of Marseilles Observatory at the age of 22, and in his lifetime discovered 13 comets. He discovered, simultaneously with Biela, that Biela's comet was identical with one seen previously, and established its periodicity. It was the second short-period comet discovered.

Gay-Lussac. This crater in the Carpathians has a chain of craterlets running across it from south to north and on into the bay to the north of it. The crater was named by Maedler for a French professor of physics and chemistry; Krieger later further honored him by giving the name **Sinus Gay-Lussac** to the bay northward of the crater.

Hortensius. A bright crater, quite deep, named for a Dutch astronomer, Martin van den Hove, professor of mathematics at Amsterdam in the 17th century, and also an observer. He worked for some time with Landsberg (see below).

Kepler. Johann Kepler (1571-1630) worked under Tycho at Prague, and from Tycho's voluminous observations derived his three laws of planetary motion. On the moon, crater Kepler is about 20 miles in diameter. It is one of the brightest spots on the moon, and the center of a system of bright rays.

Landsberg. Philippe van Lansberge was born at Ghent. His trigonometric tables were used by Kepler, and his planetary tables enabled Horrocks to observe the 1639 transit of Venus. **Who's Who in the Moon** notes that this name is correctly spelled Lansberg, or Lansbergius, as Riccioli correctly used it in its Latin

(Continued on page 13)

Twenty Americans on the Moon

By John W. Streeter, *Brown University*

THE CURRENTLY APPEARING back-cover series of Lick Observatory photographs of the moon has aroused much interest among the readers of *Sky and Telescope*. Questions have been asked, too, about the people who are represented on the moon, why they are there, and particularly what Americans have had pieces of moonscape named for them.

In the first place, it must be remembered that all the choice parcels of lunar real estate were cornered long before the United States went into business for itself. The boom came nearly 300 years ago, in 1651, when practically every desirable location was handed out by Johannes Baptista Riccioli in his ponderous book, *Almagestum Novum*. About 200 of these names remain, and they are fairly well divided between the philosophers of antiquity in northern latitudes and Renaissance figures in the south. Typical of 17th-century animosities was Riccioli's assignment of a little hole in the ground to Galileo while he treated himself to a walled plain some 100 miles in diameter.

Probably half of the observers who have drawn maps of our satellite have nominated heroes, or just friends, to the hall of fame in the moon, but few names have stuck. A hundred and fifty years after Riccioli came Schroeter, and of his choices some 60 remain. The first reasonably accurate map was the result of Beer and Maedler's classic studies, published in Berlin in 1837, with 427 names, of which 145 were new.

It was Maedler who named the first crater for an American, *Benjamin Franklin*, the only scientist of this country who had an international reputation at the time. The next to get a place seems to have been *Maria Mitchell*, first in our long line of women astronomers, who was sponsored by the little-known Englishman, Dr. John Lee, around the middle of the 19th century.

Another English amateur, W. R. Birt, in the late 1860's honored the *Bonds, William C.* and his son, *George P.*, the first two directors of Harvard College Observatory. He also named a formation for *Matthew Maury*, famous oceanographer who was first superintendent of the United States Naval Observatory, from 1844 to 1861.

In 1876, Edmund Neison, of the Royal Astronomical Society, published *The Moon*, which is to this day the classic work in English on the character of the lunar surface as a whole. Among the 513 names used, only one new American appears, but that one was a very important astronomer, *Simon Newcomb*, who died in 1909. With the acceptance of Newcomb's values for certain constants (many still in use) by the European governments, American astronomy came of age.

J. F. J. Schmidt, the German director of the Athens Observatory, in 1878 produced an enormously detailed map of the moon which included some 2,000 features not previously indicated. Of the 50 names added only two Americans owe their elevation to him, and neither was an astronomer. One was the Swiss-born *Louis Agassiz*, naturalist of the highest rank; the other was a rather obscure physician-explorer, *Elisha Kane*, of Philadelphia, who made two trips to the arctic.

At the end of the 19th century, then, the total number of our countrymen representing us on the moon was a mere eight. In the meantime, all kinds of persons were immortalized on the earth's satellite, including a goodly number of amateur selenographers of modest attainments.

In 1898, an admirer of American astronomers appeared in J. N. Krieger, son of a Bavarian farmer, who did his observing in Trieste. His lunar atlas more than doubled the American showing, as he made 10 additions:

James Lick, donor of funds for the very telescope with which the back-cover photographs were taken; *Catherine Bruce*, who gave telescopes to Harvard and Yerkes and a spectrograph to Lick Observatory; *Benjamin A. Gould*, who left the Dudley Observatory at Albany after a monumental row with the trustees and went to Argentina where he continued his magnificent work at Cordoba; *Asaph Hall*, best remembered for his discovery of the two satellites of Mars; *Henry Draper*, the most successful of the early experimenters in astronomical photography; *Charles Yerkes*, who founded the observatory at Williams Bay, Wis.; *S. W. Burnham*, the double-star observer who made such good use of the big refractors at both Lick and Yerkes; *E. S. Holden*, the first director of Lick Observatory and the man who first made lunar photographs with the 36-inch refractor; *E. C. Pickering*, long director at Harvard and father of modern magnitude standards; and finally *George W. Ritchey*, principally known for figuring the Mount Wilson 60- and 100-inch mirrors, but in 1898, while still in his thirties, already famous for his work with the 24-inch reflector at Yerkes.

This statue of Benjamin Franklin, first American to be named on the moon, is in the Franklin Institute, Philadelphia. Engraving courtesy the Franklin Institute.

The 20th-century lunar students, such as Walter Goodacre, have had the modesty not to commend to posterity selections of their own, and few newcomers have been added to named features of the moon. The lunar commission of the International Astronomical Union has, however, provided for two Americans who have done much for selenology. *Ernest W. Brown*, of Yale, spent the best part of 30 years working on the theory of the moon's motion; his tables are used by most nations for predicting positions, but he did little if any actual observing of the moon itself. Quite different was *W. H. Pickering*, younger brother of E. C. Pickering. He was an ingenious, indefatigable, and persistent observer, both visual and photographic.

This adds up to only 20 Americans, two women and 18 men, for whom features are now named on the moon. We look in vain for David Rittenhouse and John Winthrop among the earlier astronomers, and no one has yet engraved the name of G. W. Hill, W. W. Campbell, or E. E. Barnard on a lunar monument. Nevertheless, considering the haphazard way the names have been proposed, it is a remarkably fair and representative list.

ED. NOTE: In the current series of back covers, formations named for G. P. Bond, Franklin, Hall, Maury, and Newcomb appear on Plate III; for Agassiz, W. C. Bond, Kane, and Mitchell on Plate VII; for Burnham, E. Pickering, and Ritchey on Plate V. Lick and Yerkes are on Plate II, as is W. H. Pickering, while the others are scattered.

Amateur Astronomers

Convention Program and Rules for Exhibits

TWO AND A HALF full days of activities will mark the national convention of amateur astronomers to be held in Philadelphia on Friday, Saturday, and Sunday, July 4th, 5th, and 6th. Headquarters for the gathering will be the Franklin Institute, 20th St. and the Parkway, where events are scheduled for each day. An exhibition covering many phases of the work of amateur astronomers will be in the museum of the Institute, while the business sessions will be held in the adjoining lecture hall.

Excursions to two nearby observatories have been planned, as well as a special demonstration in the Fels Planetarium of the Franklin Institute. Arrangements for the entire convention are being made by representatives of the co-host societies, the Amateur Astronomers of the Franklin Institute and the Rittenhouse Astronomical Society.

This is a tentative program for the three-day convention:

Friday, July 4th

9:00 to 10:00 a.m. Registration of delegates and visitors in the Fels Planetarium lobby of the Franklin Institute. Registration fee, $1.00.

10:00 a.m. — noon. Opening session of convention. Discussion of problems of amateur astronomical societies. Report on activities of amateur groups. Report of Amateur Astronomers League. Lecture Hall, the Franklin Institute.

Noon — 2:00 p.m. Lunch. Delegates and guests are on their own for the midday meal both Friday and Saturday. The Dairy Dell, on the ground floor of the Institute, offers soup, sandwiches, ice cream, and inexpensive platter lunches. Holland's Restaurant, 114 N. 19th St., about three minutes' walk from the Institute, offers well-rounded menus. Other restaurants and cafeterias are also within walking distance.

2:00 — 4:00 p.m. Session for reports of work of amateurs, telescope making, etc. (Papers are limited to 15 minutes. Please notify the Program Committee of your subject as soon as possible, indicating whether or not you will need a projector or other equipment.) Astronomical films and filmstrips. Lecture Hall.

5:00 p.m. Buses leave Planetarium entrance for trip to Sproul Observatory, Swarthmore College. Round-trip fare, $1.00. Picnic or buffet supper at Swarthmore (cost $1.00) depending on weather conditions. If it is clear, the 24-inch refractor and other equipment will be available. (Sproul has a 24-inch instrument, and not a 28-inch, as incorrectly stated last month.) If the sky is cloudy, a special program will be arranged by Dr. Peter van de Kamp, director of Sproul Observatory, and his associates. Buses will return to Philadelphia at adjournment of this session.

Saturday, July 5th

9:30 a.m. — noon. Session for reports. Discussion of amateur observing programs. Films. Demonstration of teaching aids. Lecture Hall.

Noon — 2:00 p.m. Lunch. Same as Friday. See above.

2:00 — 5:00 p.m. Visit to the museum of the Institute, including special exhibit of the work of amateur astronomers. (See below for exhibit rules and details.)

5:00 p.m. Buses leave Planetarium entrance for trip to Haverford College, round-trip fare, $1.00. Banquet will be held at Haverford at 6:30 p.m., cost, $2.50. Following the banquet, the group will go to Strawbridge Observatory of Haverford College, where demonstrations will be given of the newly installed Peerless Planetarium. Weather permitting, there will be telescopic observing in the dome of the observatory. The observatory classroom and library offer opportunities for meetings of small discussion groups. Buses will leave for Philadelphia at the adjournment of this meeting.

Sunday, July 6th

9:00 a.m. Convention breakfast in the Dairy Dell, at the Institute. Cost, $1.00.

10:00 — 11:00 a.m. Final business session. Reports of committees. Award of prizes.

11:00 a.m. Special demonstration of the Fels Planetarium, by Dr. Roy K. Marshall, director.

Noon. Adjournment of the convention.

Costs. The following charges have been established as maximum prices. If conditions permit, these will be revised downward by the time the convention begins:

Registration fee	$1.00
Round-trip bus fare, Swarthmore	1.00
Supper at Swarthmore	1.00
Round-trip bus fare, Haverford	1.00
Banquet at Haverford	2.50
(This is only part of the banquet cost — the balance is being underwritten.)	
Breakfast in Dairy Dell	1.00

The total cost of these activities is $7.50. Tickets for each separate activity are to be purchased at the time of registration on Friday morning. Last-minute reservations cannot be accepted. Reservations must be made in advance by mail if you are going to register late for the convention. Hotel accommodations, Friday and Saturday breakfasts and lunches, and other incidental expenses must, of course, be paid by individuals.

Hotels. Two hotels, each within 10 minutes' walk of the Franklin Institute, have expressed their willingness to accommodate convention delegates. The costs run upward from $2.25 a day, for a single room with running water, with special rates for groups which can share rooms. The Robert Morris Hotel is at 17th St. and the Parkway, and the Warburton Hotel is at 20th and Sansom Sts. The Reservations Committee of the convention will refer requests for rooms to either of these two convenient hotels, and the delegates will be notified directly of the rooms assigned.

The exhibit. The 1947 astronomical exhibit includes seven classes of entries, and is to be held in the museum of the Franklin Institute on July 4th to 6th, the days of the convention. The exhibit rules are given here. An impartial board of judges will award all prizes. This

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THIS MONTH'S MEETINGS

Chicago: The Burnham Astronomical Society will meet at the Chicago Academy of Sciences Auditorium on Tuesday, June 10th, at 8:00 p.m. There will be an astronomical symposium conducted by members, covering the subjects of the June evening sky, William Herschel, Saturn, the 200-inch telescope, and wonders of the universe.

Cincinnati: On Friday, June 13th, there will be open house at the Cincinnati Observatory for members of the Cincinnati Astronomical Association and their families only.

Detroit: A field trip to Cranbrook Institute of Science, Bloomfield Hills, will constitute the meeting of the Detroit Astronomical Society on Sunday, June 8th. The members will meet at the Institute at 3:00 p.m., along with members of the Windsor Centre of the Royal Astronomical Society of Canada. There will be a tour of the Cranbrook Institute conducted by its director, Dr. Robert T. Hatt, followed by picnic supper and observing with the 6-inch refractor, operated by William Schultz, Jr.

Indianapolis: The Indiana Astronomical Society will meet on Sunday, June 1st, at Odeon Hall at 2:15 p.m. Russell Sullivan will talk on "Through the Telescope."

Kalamazoo: At the home of Mr. and Mrs. D. C. Lawrence, 307 Woodward, Comstock, the Kalamazoo Amateur Astronomy Association will hear a talk by Alfred Bryant on "The Sun." The meeting is on Saturday, June 21st.

Madison: The annual picnic of the Madison Astronomical Society will be held on Wednesday, June 11th. There will be election of officers.

Pittsburgh: On Friday, June 13th, Fred M. Garland, member of the society, will speak to the Amateur Astronomers Association of Pittsburgh about "Snow on the Moon." The meeting begins at 8:00 p.m., in the lecture hall of the Buhl Planetarium.

Washington: Dr. Alvin G. McNish, of the National Bureau of Standards, will speak at the meeting of the National Capital Astronomers on Saturday, June 7th, at 8:00 p.m. in the Commerce Department Auditorium. His subject will be "Detection of Meteors by Radar Methods."

board will include one amateur astronomer, one professional astronomer, and one non-astronomical educator.

Classes of Exhibit.

I Amateur-made telescopes and accessories.

II Photos of amateur-made telescopes, etc.

III Astronomical photographs with amateur telescopes.

IV Paintings of astronomical subjects.

V Models of astronomical subjects.

VI Astronomical demonstration and teaching devices.

VII Miscellaneous.

Rules for Photographs (Classes 2 and 3).

Prints must be not less than 4 x 5 inches. They may be mounted or unmounted, but should not be under glass. The name and address of owner should appear on the back of each photograph. An additional sheet should give name and address and complete description of photograph, giving all information that amateurs would be interested in having. An entry fee of 25c (stamps or coin) will be charged for each photograph. Return postage must be sent when photos are submitted.

Rules for Other Exhibits (Classes 1, 4, 5, 6, 7).

All packing, shipping and delivery costs must be assumed by exhibitor. Return costs should be sent when exhibits are shipped to us. **All entries are the owners' own risk.** The value of each exhibit must be stated on entry blank. An entry fee of $1.00 for each exhibitor will cover each display regardless of the number of items submitted. All separate parts must be clearly marked with name and address of exhibitor. Full description must accompany each exhibit. Exhibits may be brought with you when coming to the convention, but registration must be made in advance so that display can be arranged. All exhibits sent by mail, freight, or express should be clearly addressed to:

Edwin F. Bailey
The Franklin Institute
Philadelphia 3, Pa.

and should be marked as Amateur Astronomers Convention material. They should be delivered to the Franklin Institute between June 25th and July 1st, 1947.

In entering an exhibit, please notify Mr. Bailey as soon as possible of the number of items to be included with a complete description and valuation of each. Indicate the size and weight and any special service required (table, electric outlet, panel, etc.). Include the proper entry fee so that space can be allocated without delay.

For further information concerning any of these details, to make hotel and other reservations, enter exhibits, or to list a paper to present before the convention, address:

Amateur Astronomers Convention Committee
The Franklin Institute
Philadelphia 3, Pa.

The Franklin Institute in Philadelphia will be the main meeting place for the convention of amateur astronomers on July 4th weekend. Entrance to the Fels Planetarium is on the right hand side of the building as it appears here. Engraving courtesy the Franklin Institute.

Popular Astronomy Club of Moline

A very interesting display of telescopes and parts was on exhibit at the 11th annual banquet of the Popular Astronomy Club of Moline, Ill., on March 26th. These included a model of the 18-inch telescope being constructed by members of the club. The secondary mirror is completed and the large mirror is ready for aluminizing. Work is progressing on the making of the mount, and we soon expect to have a fine instrument which will be a proud possession of all club members.

At the banquet, which was attended by 150 persons, the speaker of the evening was Dr. Thornton L. Page, of the department of astronomy of the University of Chicago. He showed four astronomical motion pictures, and afterward conducted an enjoyable question-and-answer period.

Our president, Carl H. Gamble, was presented with a bronze sundial by the members. Mr. Gamble talked about the future plans and objectives of the club.

R. S. YOUNG, secretary
Popular Astronomy Club
Moline, Ill.

FIREBALL REPORTS WANTED

A letter from Lee Russell, of Okean, Ark., describes a bright, slow-moving meteor he observed about 8:07 p.m. April 15th. He was facing south, and saw the meteor travel from a point above Spica to near the horizon in the southwest. He writes:

"I at first thought it was a light on an airplane, but quickly saw that it was a meteor. Its duration of flight was approximately seven or eight seconds. Its color was light red mingled with light blue in the tail. At its greatest brightness it was about twice as bright as Sirius; just before it reached the horizon it faded away with a red glow."

Mr. Russell's letter and sketch of the meteor's path among the stars are being transmitted to Oscar E. Monnig, 1010 Morningside Drive, Fort Worth 3, Tex., for presumably this is the same meteor discussed by him in the **Texas Observers' Bulletin** for April. From New Orleans to Memphis and Little Rock, on that Tuesday evening, hundreds of persons must have observed the meteor. It apparently passed in a northwestward direction from the region of McComb, Miss., past Jackson, Vicksburg, and Greenville, and ended somewhere over southern Arkansas. Observations such as Mr. Russell's, from a point in northern Arkansas, show the wide area over which the meteor was seen. All persons who can help to establish the altitude and azimuth of either beginning or end point (or both) of this meteor's flight should write to Mr. Monnig immediately.

IN FOCUS

(Continued from page 10)

form. On the moon, this formation has terraced walls and a central peak.

Parry. This ring plain, with rather broken walls, was named for a British arctic explorer, who in 1827 attained latitude 82° 45′ N., an achievement which remained unsurpassed for about 50 years.

Stadius. An irregular plain with walls practically invisible has a most striking collection of tiny craterlets in and near it, particularly those stretching northeastward.

Turner. A small, deep crater is named for Herbert Hall Turner (1861-1930), who worked at Greenwich Observatory and was later Savilian professor at Oxford. He was influential in the organization and work of the Astrographic Catalogue and charts, the Carte du Ciel, co-operative observing program started toward the end of the last century. He discovered Nova Geminorum in 1903, and did important work on variable stars and in seismology.

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BOOKS AND THE SKY

AN INTRODUCTION TO THE STUDY OF ECLIPSING BINARIES

Zdenek Kopal. Harvard University Press, Cambridge, 1946. 220 pages. $4.00.

IN THIS MONOGRAPH Dr. Kopal sets out (as he states explicitly in the first chapter) to present an integrated picture of the geometrical, dynamical, and physical theory needed for the interpretation of precise light curves of eclipsing binaries. He has kept strictly to this objective throughout except for some excursions into the field of procedure in solutions.

It is well known that eclipsing binaries are storehouses of a wealth of information on stellar attributes. But this very statement has as its necessary counterpart the statement that the number of parameters, or characterizing constants, necessary to describe an eclipsing binary system completely in all its varied aspects is far greater than that for any other class of celestial objects known; no less than 16 constants are required completely to specify even the idealized model consisting of prolate spheroids revolving in circular orbits. This means that the observed light curve is the resultant of such a complex of natural factors that it becomes literally impossible to interpret that curve except through step-by-step approximation methods.

Both the theoretical and the computing investigator must start with spherical stars moving in circular orbits, and introduce one after another the refinements which convert that physically impossible model into one which is in reasonable agreement with nature as we know it; that is, they must consider first the light curve which the simplified system would exhibit and then the various modifications of it (some by no means small) brought about by the improvement of model. It is to the derivation of quantitative expressions for these modifications, to a precision equaling or somewhat surpassing that of the best present observational material, that Dr. Kopal devotes most of his book. Furthermore, because he is mainly synthesizing researches already published by others or (in many cases) by himself, he has in many instances given in the text only outlines of the arguments by which the conclusions are reached and has referred the more thorough reader to the original papers through either footnotes on the pages or the extensively annotated bibliographies at the ends of the chapters.

The book divides rather naturally, after the first chapter, into two main parts, Chapters II to V and Chapters VI to IX, the former having to do with spherical stars and the latter with distorted ones. Chapter I is introductory, attempting to give the reader some historical and astronomical perspective on eclipsing binaries.

Chapters II and III set up the mathematical equations for the light lost during eclipse of one spherical star by another pursuing a circular orbit around it, and describe the main features of the methods developed by Russell, Fetlaar and Kopal to handle this case. The rather extended theoretical discussion of the relative merits of these methods perhaps loses some force when the reader finds on page 56 the statement that " . . . all methods described . . . yield the various elements with approximately the same intrinsic weight . . . ," and in any case the discussion seems to your reviewer to miss the point completely so far as evaluating the usefulness of graphical clues and free-hand preliminary curves is concerned.

Chapter IV discusses the improvement of the "spherical-circular" elements by least-squares corrections, if and when the observational material warrants expending that labor on this "spherical" case, and the low weights to be assigned to the derived corrections to the assumed degrees of darkening. Chapter V then discusses in elegant fashion the vexing problem of elliptic orbits and resulting shapes of light curves; it provides, in effect, firm theoretical grounds for handling each of the two eclipses in an elliptic orbit (when one is total and the other annular) as if the motion were circular throughout the duration of that eclipse. From this point of view, the elliptic elements finally achieved belong in the class of "improvements" on the preliminary circular ones.

At this point, the idealization of spherical components gives way to the reality of tidal and rotational distortion; the remaining four chapters deal with the mathematically and physically intricate problem of light curves of distorted stars and (by logical connection) with the reflection effect frequently observed in close pairs.

In Chapter VI, Dr. Kopal derives equations specifying the shape assumed by a star in radiative equilibrium under the influence of its own gravitation, its rotation, and the tidal stresses from its companion. To make the problem reasonable to handle he assumes explicitly that the harmonic terms are always numerically small enough so that their squares can be neglected. The extent to which this assumption is safe is at present not known, and Dr. Kopal very properly reiterates frequently in this second part of the book the warning that for **very** close pairs this neglect may lead to incorrect conclusions from the light curve. The latter part of the chap-

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ter is occupied with a proof of von Zeipel's theorem that the brightness at any point of the disk of the star is proportional to the value of surface gravity there, that is, is occupied with a derivation of the equation of variation of brightness over the disk including gravity darkening as well as limb darkening.

Since the external form of component now to be postulated is neither sphere nor prolate spheroid but something rather resembling the shape of a shelled three-minute egg lying on its side, even the distribution of brightness over the uneclipsed limb-darkened, gravity-darkened disk obviously must be highly complex mathematically, while the loss of light occasioned by partial obscuration of this disk by another of distorted outline must be of even more complex character. In addition there must be taken into consideration the variation of brightness over the visible disks due to the so-called reflection of the light of one component which is incident on the other, and still further, the eclipse effect on this radiation reflected from the component undergoing eclipse. These are the problems Dr. Kopal treats in the remaining three chapters of the monograph.

Chapters VIII and IX represent the goals toward which Dr. Kopal has been working in the previous chapters: first, the explicit equation for loss of light of a distorted component being obscured by a distorted companion; second, derivation of elements of a physically possible system, by this equation, by "improvement" from the parameters of the prolate-spheroid or second-approximation stage. The distortions of the eclipsed star turn out more troublesome than those of the eclipsing, but Dr. Kopal finally arrives at two expressions for the loss of light due to eclipse, one for uniform disks and one for limb darkening complete. In a separate paper, he has evaluated all functions concerned, to the accuracy he believes warranted, so that the stage is set for full-dress investigation of the very best observed light curves we have. With Dr. Kopal presently engaged in applying these functions to superior observational material we may look forward to rapid progress in third-approximation interpretation of light curves of eclipsing binaries.

This book, as a theoretical investigation of the important problem of extracting more of the wealth of information locked up in these light curves, is certain both to give impetus to work in an already active field and to enhance the high standing of its author in that field.

JOHN E. MERRILL
Hunter College

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Some constellations have lines joining their principal stars; some principal stars are named; some constellations are named; but not all nor nearly all in any case. Obviously, the beginner will be handicapped by these inconsistencies, and this writer suggests considerable attention be paid to this matter in the next edition of the chart. Also, too many unimportant stars confuse the chart, and the bright ones suffer from inaccurate plotting. C. A. F.

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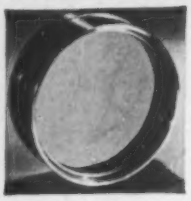

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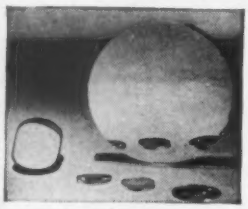

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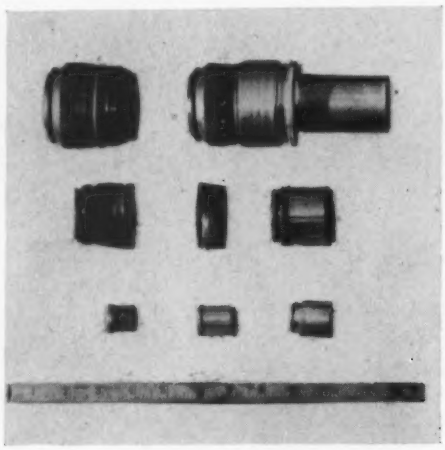
SOME AMATEURS make telescopes but do not use them. Some use telescopes but do not make them. The writer has found that he gets maximum enjoyment from an intermediate policy. There is no pleasure equal to that derived from buying a telescope which is good optically but poor mechanically, using it on the stars, and then improving it until it is transformed from a clumsy and perhaps nearly unusable instrument into a smoothly working, handy telescope.

Almost every telescope which I have ever had the privilege of using has been poor mechanically in one or more ways. Apparently, only actual use of a telescope can indicate the improvements that are needed. There are no rules or established principles to go by. Common sense, ingenuity, and some ability to use ordinary tools are all that are required. Difficult jobs can best be done by a machine shop.

The professional telescope maker who turns out several instruments of a certain model is more likely to get rid of the mechanical "bugs" than the amateur who makes only one of a kind, but professional equipment is by no means perfect. For instance, in 1932, when there were no war-born shortages of labor and material, a new 6-inch refractor was purchased from one of the best makers. Use on the stars soon showed that it suffered from the following defects or omissions:

The dust cover on the objective fitted so tightly it had to be pried loose with a screw driver each night. The finder had no dust cap. No dew caps were provided for either the 6-inch or finder objective. The finder tube was too long, so that the finder would not quite focus. The telescope needed a longitudinal balance weight. The main counterweight was too small even for the telescope as received, and it had to be increased in size. The slow-motion control rods had to be equipped with lock screws and supporting brackets, otherwise they dropped off. The eyepieces had too small a field of view for satisfactory use on the sun, moon, nebulae, comets, and variable stars. Even the lowest-power eyepiece, of 75 power, had so small a field that it would not show the entire moon. The end of the eyepiece tube was flimsy and it was continually getting knocked out of alignment. Some of these defects were easily remedied; others, such as the eyepiece deficiencies, were not.

Since 1932 the writer has rehabilitated a number of fine old reflectors and refractors. Usually it is possible and best



Wartime eyepieces as adapted for astronomical use. Top: 1½-inch Jaegers as received and as adapted with a 2-inch bushing to fit the author's 6.2-inch refractor. Middle: 1¼-inch Edmund Salvage as received; focusing ring removed; with 2-inch bushing. Bottom: Harry Ross M-1 Kellner as received; with 1-inch bushing; fitted into 1¼-inch bushing.

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to keep a telescope in service so as to try out each new improvement on the stars after it has been made. This method has been followed in the latest case which offers features of interest. Before describing it, however, I wish to interject two comments on eyepieces. The first is that ordinary eyepieces are ill adapted for use by those of us who, because of astigmatism, must wear glasses at the eyepiece. Glasses force the eye so far back from the eyepiece that only the center of the field can be seen. So-called "high-eyepoint" eyepieces overcome this defect, as the entire field is visible even if the eye is an inch or more back of the eye lens. Since the war a number of high-eyepoint eyepieces have become available, ranging all the way from very low power to medium power. Some are of 4¾-inch focal length with eye relief of 6½ inches; some 1½-inch focus, eye relief 1½ inches, diameter two inches; and some are small Kellners and orthoscopics of about ¾-inch focus and ¾-inch eye relief. Installation of these eyepieces on my telescope has enabled the writer, who must wear glasses all the time, to experience for the first time the delight of being able to see a really wide field of view through the telescope.

The second comment is that the time has come to set up the next larger standard size in eyepieces, and two inches outside diameter is suggested as most suitable. If required, three inches could be the third and largest size. For a number of years the 1¼-inch outside diameter standard eyepiece originally adopted by Mogey has worked well, though by no means all makers have standardized on it. Now, however, the lower-power wartime eyepieces of large diameter and very wide field of view call for larger diameter eyepiece tubes. In particular, Edmund Salvage Company and Harry Ross have sold wide-angle eyepieces of 1¼-inch focus with field lenses about 1.6 inches in diameter. They can be adapted nicely to fit into a 2-inch tube. And A. Jaegers has a still larger wide-angle eyepiece of 1½-inch focal length with a 2-inch field lens. I have adapted this "Giant Jaegers" to a 2-inch eyepiece tube, but a 3-inch inside diameter eyepiece tube would be better for this eyepiece, and perhaps for some others which have been advertised.

In 1945, I purchased a refracting telescope of 6.2 inches aperture and 93-inch focal length. This was made by Elroy Gray, North Jay, Me. He finished it in 1936, about four years before his death in 1940 at the age of 80. The objective and three eyepieces are excellent, but Mr. Gray's focusing device consisted of a simple drawtube. Twenty years ago I would not have been able to use the telescope, for focusing is one of the hardest things for an inexperienced telescope user. The telescope was just usable for making observations on the sun, variable stars, and Mars during the winter of 1945-1946. Remodeling, however, was imperative.

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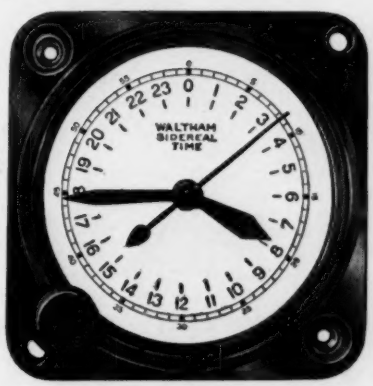

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31 mm Dia.	172 mm F.L. coated,	ea.	1.25
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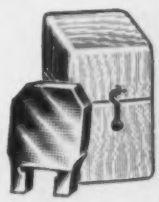

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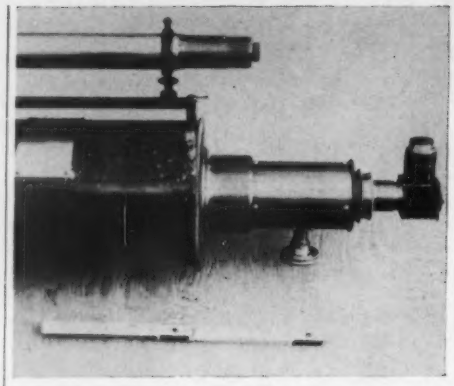
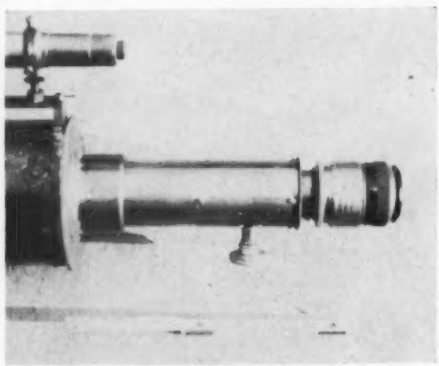


Tailpiece of the Gray refractor with solar eyepiece. The tailpiece is focused way in. Compare with the picture below.

to perfection. Considerable longitudinal travel was needed. For instance, when a zenith or solar prism with a 1-inch Huygenian negative eyepiece of 1¼-inch outside diameter is used, the focusing point is way in, while with the Jaegers 1½-inch positive eyepiece in the straight position the eyepiece tube end must be eight inches farther out. This range of travel was achieved by making the rack and pinion carry four inches, by the judicious use of extension bushings, and by designing the tailpiece so that the central 3-inch diameter tube, which encases the rack-and-pinion device, can be slid out four inches. This 3-inch tube fits in the heavy brass casting which bolts to the end of the telescope tube. Mr. Noyes designed the rack and pinion with an adjustable cone-type brake, so that when the telescope is pointed toward the zenith the weight of the eyepiece "gadgets" will not pull the eyepiece tubing out to its fullest extent.

To eliminate the need for a longitudinal balancing weight on the telescope tube, the balancing with gadgets of various weights at the eyepiece is achieved by shifting the whole telescope back or forward in its cradle. A scale on the tube shows the balancing points for different conditions; these points differ by as much as 3¼ inches.

In order to facilitate installing the focusing tailpiece true with the main telescope axis, Mr. Noyes suggested the following method of squaring off the end



Tailpiece of the Gray refractor with 1½-inch Jaegers in place with its bushing. The tailpiece is way out. This and the picture above show the longitudinal travel required for the eyepiece holder.

of the telescope tube. Set up the tube in two V-blocks of wood, with the objective end resting firmly against a third block of wood. Rotate the tube by hand in the V-blocks. Set up a cutting tool at the eye end of the tube, and during the course of an hour or two turn the end of the tube square.

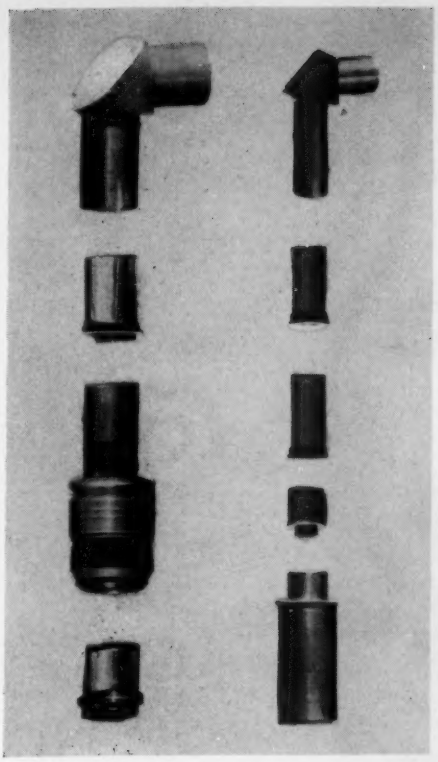
The writer had to modify this procedure because the Gray refractor tube was not seamless but had a butt joint, with the seam covered by a plate of metal on the outside of the tube from end to end. Furthermore, it sprang a little out of round when the tailpiece casting was not in place to hold it round. The writer has a light wood- and metal-working lathe. Three thicknesses of ¾-inch plywood were glued and bolted together. A central bolt projected three inches and this was used to grip the plywood in the lathe chuck. The plywood was then turned into a plug which just fitted inside the refractor tube. The lathe tailpiece was removed, and an outboard bearing was rigged up with two ball bearings so that the inside of the objective end of the tube (which was round while the outside was not) rolled on these bearings. It was then possible to drive the entire tube from the lathe headstock and to turn the eyepiece end square.

In practice, it was found better to rotate the tube by hand as the slowest motor drive was too fast for such a large object in so small a lathe. When the end of the telescope tube was thus squared off, the focusing tailpiece was slid into the tube and the flat turned collar was pressed firmly against the squared end of the tube. When bolted in place the focusing tailpiece appeared to be in perfect alignment with the main tube.

The rack-and-pinion focusing tailpiece was made with an eyepiece tube two inches inside diameter. Thin-walled brass tubing of 2-inch outside diameter was secured from a local plumber, and bushings were made from it so that the original three Gray eyepieces, an Edmund Salvage, and a Harry Ross eyepiece are now all of two inches outside diameter. A 2-to-1¼-inch adapter was also made so that standard 1¼-inch eyepieces, solar and zenith prisms can be used if desired. For planetary work, standard eyepieces of ¾-inch, ½-inch, and 1/3-inch focal lengths are needed.

The Gray telescope, with its new tailpiece and its wartime eyepieces, is now in use. With the 1½-inch Jaegers, which has a 2-inch field lens, 12th-magnitude stars are easily seen and 13th-magnitude stars with some effort. The power is 62 and the field of view 70 minutes of arc, or more than the diameter of two full moons. Those who know their variable stars will appreciate how large a field this is when it is realized that it exceeds the entire area of an AAVSO "d" chart. With this eyepiece the outer portions of the Andromeda nebula can dimly be seen extending right to the edges of the field of view.

The Edmund Salvage 1¼-inch eyepiece, which has a 1.6-inch field lens, gives a power of 74 and a field of one degree. This, too, is phenomenal, and observers with instruments of shorter focus than the 93 inches of the Gray refractor might find it of more use than the lower power



Comparison of 2-inch equipment and 1¼-inch. From top to bottom: left, zenith prism, 2-inch Huygenian in adapter tube, 1½-inch Jaegers in adapter, 1¼-inch Edmund Salvage eyepiece; right, zenith prism, 2-inch Mogey Huygenian, 1½-inch Mogey Huygenian, 1¼-inch B&L Kellner, 1¼-inch-to-2-inch diameter adapter or bushing.

Giant Jaegers. The M-1 Harry Ross Kellner eyepiece of about 0.8-inch focal length gives a power of 117 and a field of 24 minutes. This little eyepiece shows 13.2-magnitude stars continuously and pushes the telescope toward the upper limit of its usefulness in observing faint variable stars. For smaller instruments, this eyepiece is better than the larger, very wide-angle eyepieces, because for most amateur purposes a power of from 30 to 60 is best. The writer, for instance, has 3-inch and 4-inch refractors, and this eyepiece is used for observing the sun with these instruments. The power is from 40 to 45, which is as high as the sun will usually stand without becoming fuzzy from heat waves in the atmosphere.

With the Jaegers and Edmund Salvage eyepieces, some vignetting occurs, but it is imperceptible to the eye in use. What is vignetting? When some of the light from the outer portions of the objective or mirror cannot reach the corresponding outer portions of the field lens of the eyepiece, vignetting occurs. This effect may be encountered in a refractor if the diaphragms in the telescope tube are too small. It was found necessary to enlarge the openings in the diaphragms of the Gray so that these openings just encircle a truncated cone, the base of which is the 6.2-inch objective and the top of which is a circle the size of the largest eyepiece field lens — two inches in diameter — located at the focusing point of the eyepiece.

In a Newtonian reflector, vignetting occurs if the diagonal is too small. Binoculars suffer from vignetting caused by the limited size of the prisms through which the light passes. Some binocular makers specify the amount of this vignetting, and it may run to as much as 45 per cent light loss at the edge of the field of view, even in the best instruments.

Usually, in both reflectors and refractors, some vignetting is caused by the front end of the 1¼-inch inside diameter eyepiece tube, which is very little larger in diameter than the field lens of any low-power eyepiece of between one and two inches focal length. Therefore, if it is too long, the front end of the eyepiece tube prevents some of the rays from the outer zone of mirror or objective lens from reaching the outer edges of the field lens of the eyepiece. The 4-inch refractor mentioned above is of 32 inches focus, that is, f/8, made by Keuffel and Esser for use in World War I. The tail end of this instrument had to be completely overhauled and equipped with larger diameter tubing to permit the full cone of light from the objective to reach all portions of the 1-inch diameter field lens of the Kellner eyepiece which is used

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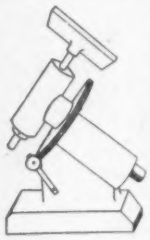

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with it. This telescope is now extremely good for variable star work, because of its wide field and because vignetting is almost if not entirely eliminated, so that stars maintain their full brightness right to the edge of the field of view.

Because of their shorter focus, reflectors are more subject to vignetting than refractors, except in the case of short-focus refractors, as above. When high-power eyepieces are used, however, vignetting by the eyepiece-holder tube may not occur at all, because of the smaller field lenses common to such eyepieces.

A quick test for vignetting in any telescope is to remove the eyepiece and to place the eye where the field lens was. Then move the eye around in a little circle approximately the same diameter as the field lens of the eyepiece in question. If at the periphery of this little circle one cannot see the entire disk of the mirror or objective, then vignetting is taking place. However, if one can see two thirds of the objective or mirror area, the vignetting is not severe. If at the exact middle point all of the objective cannot be seen, then the effective aperture of the instrument is only the area that is visible. When using my 3-inch f/12 refractor terrestrially, a prismatic erector is inserted in the optical train. Unfortunately, this cuts the effective aperture to 2½ inches, because only an area of this size can be seen in the experiment just described. For mechanical reasons nothing can be done about this. In this case, however, vignetting in the sense of variation of brightness over the field is not present because 2½ inches of objective are in view from any part of the field lens of the eyepiece, although, of course, it is not the same 2½ inches at all points.

DAVID W. ROSEBRUGH
87 Fern Circle
Waterbury 69, Conn.

The Telescope on Mount Palomar

From the report of the Rockefeller Foundation for 1946, by Raymond B. Fosdick, president of the foundation, the following is extracted:

The funds for the erection of the giant 200-inch telescope on Mount Palomar in California have been supplied by three Rockefeller boards: The International Education Board, the General Education Board and The Rockefeller Foundation. In 1946 the Foundation made a final grant of $250,000 to complete the project, bringing to a total of $6,250,000 the funds appropriated to the California Institute of Technology for this unique instrument of scientific research.

The first grant was made in 1928. The project presented extraordinary engineering and mechanical difficulties, and a number of years elapsed before successful solutions were found for the problems of casting so large a block of suitable glass, of grinding and polishing it to a precise curvature within a few millionths of an inch, and of supporting the huge mass of 530 tons so that the telescope could be moved almost without friction to follow the pinpoint of a star across the skies.

The project was delayed more than four years by the war, but the grinding of the lens is now essentially completed, the supporting structure is ready, and it is expected that final assembly will occur during the summer of 1947, with the whole equipment in operation by the end of the year. This equipment includes not only the 200-inch telescope, but the smaller observatories for the three auxiliary or "scout" telescopes, as well as a dormitory, a power plant, water and gas systems, a small museum and seven cottages for the maintenance staff.

What is the justification for this huge expenditure of money and effort? The answer, in general terms, lies in the unconquerable exploring urge within the mind of man. This new telescope will project man's sight into the universe two times farther than it has ever gone before — to a distance more than a thousand million light-years away. It will open up an unexplored sphere 8 times the volume of that which has hitherto been sounded. What lies beyond the limits of our present knowledge? Do the stellar systems extend on indefinitely, or is a boundary finally reached beyond which there are fewer and fewer nebulae? What is the true interpretation of the immense velocity with which all the stellar systems appear to be receding? Is it a pseudo-velocity caused by a curvature of space or by some property of light? Why from the dim frontiers of space do the countless Milky Ways send light that with strange uniformity shifts always to the red end of the spectrum? Since stars and nebulae are vast aggregations of atoms or atomic fragments, reacting on each other under conditions of pressure and temperature beyond anything that can be duplicated in man's laboratories, what secrets can we learn that will add to our knowledge of fundamental physics?

But this knowledge is dangerous, it will be said. Of course it is dangerous. All knowledge is now dangerous. Indeed, knowledge has always been dangerous. For knowledge means power, and power can be used for evil purposes as well as good. But the answer does not lie in trying to curb science or fix boundaries beyond which intellectual adventure shall not be allowed to go. Such a course, even if it could succeed, would return us to an animal existence in which mere survival was the only goal. The search for truth is, as it always has been, the noblest expression of the human spirit. Man's hunger for knowledge about himself, his environment and the forces by which he is surrounded, gives human life its meaning and purpose, and clothes it with final dignity.

Civilization is not being betrayed by science. The betrayal, if it comes, will be by men who do not know how to use science wisely. The telescope on Mount Palomar is a mighty symbol of man's unique distinction: his aspiration to know. Whether that distinction will become the instrument of his own destruction depends upon how rapidly he can travel the long road toward goals of social organization and moral control that are now only faintly seen on the horizon.

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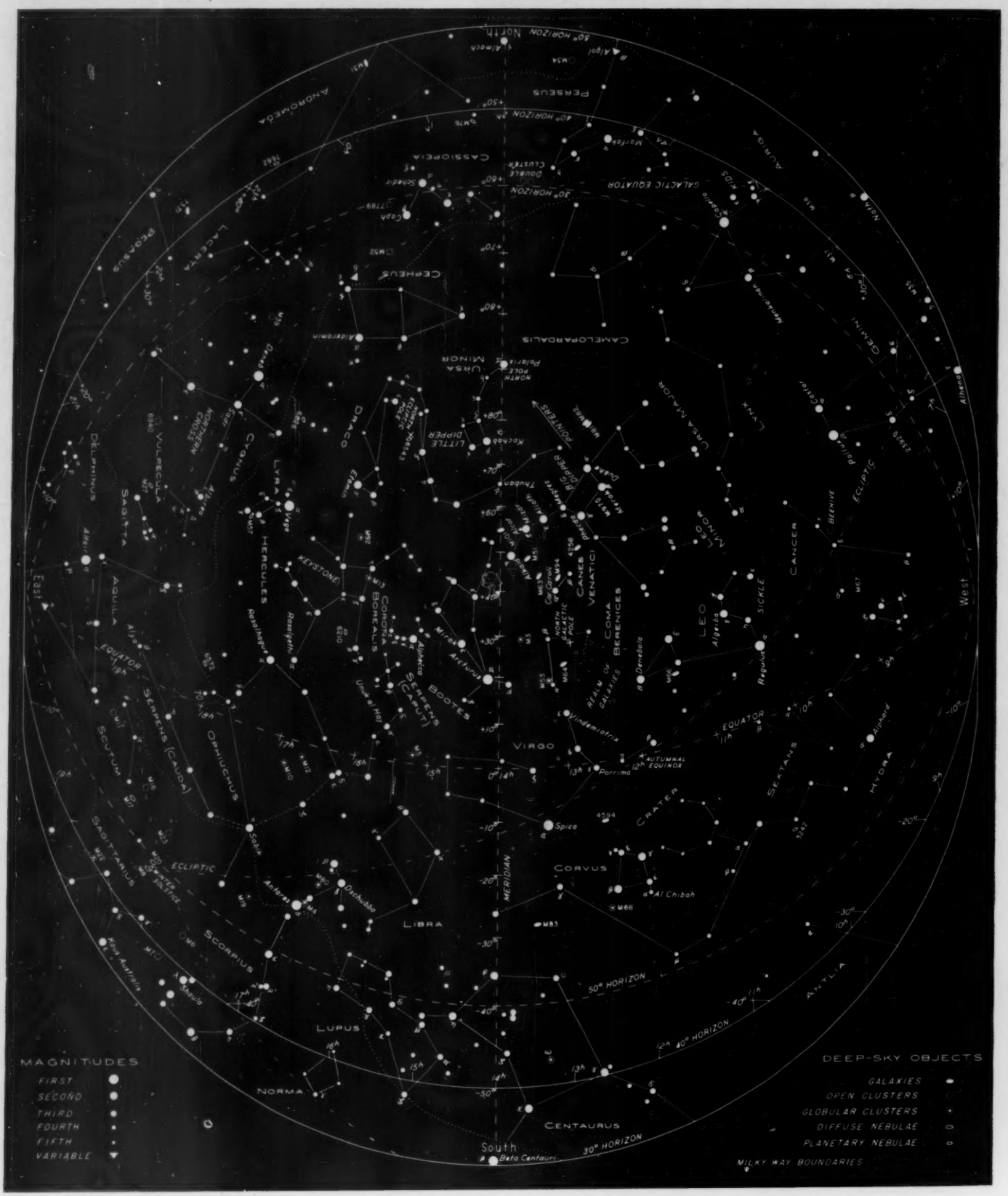


DEEP-SKY WONDERS

AMONG the many galaxies in Canes Venatici, one of the brighter spirals is NGC 5055, M63, 13h 14m, +42° 18′. Its brightness increases toward the nucleus; it is an Sb-type spiral, magnitude 10.5, measuring 8′ x 3′.

Also in Canes Venatici is the Whirlpool nebula, the famous M51, all one spiral although catalogued by the NGC as two objects. NGC 5194, 5195, 13h 28m, +47° 27′, 12′ x 6′ and 2′ x 1.5′.

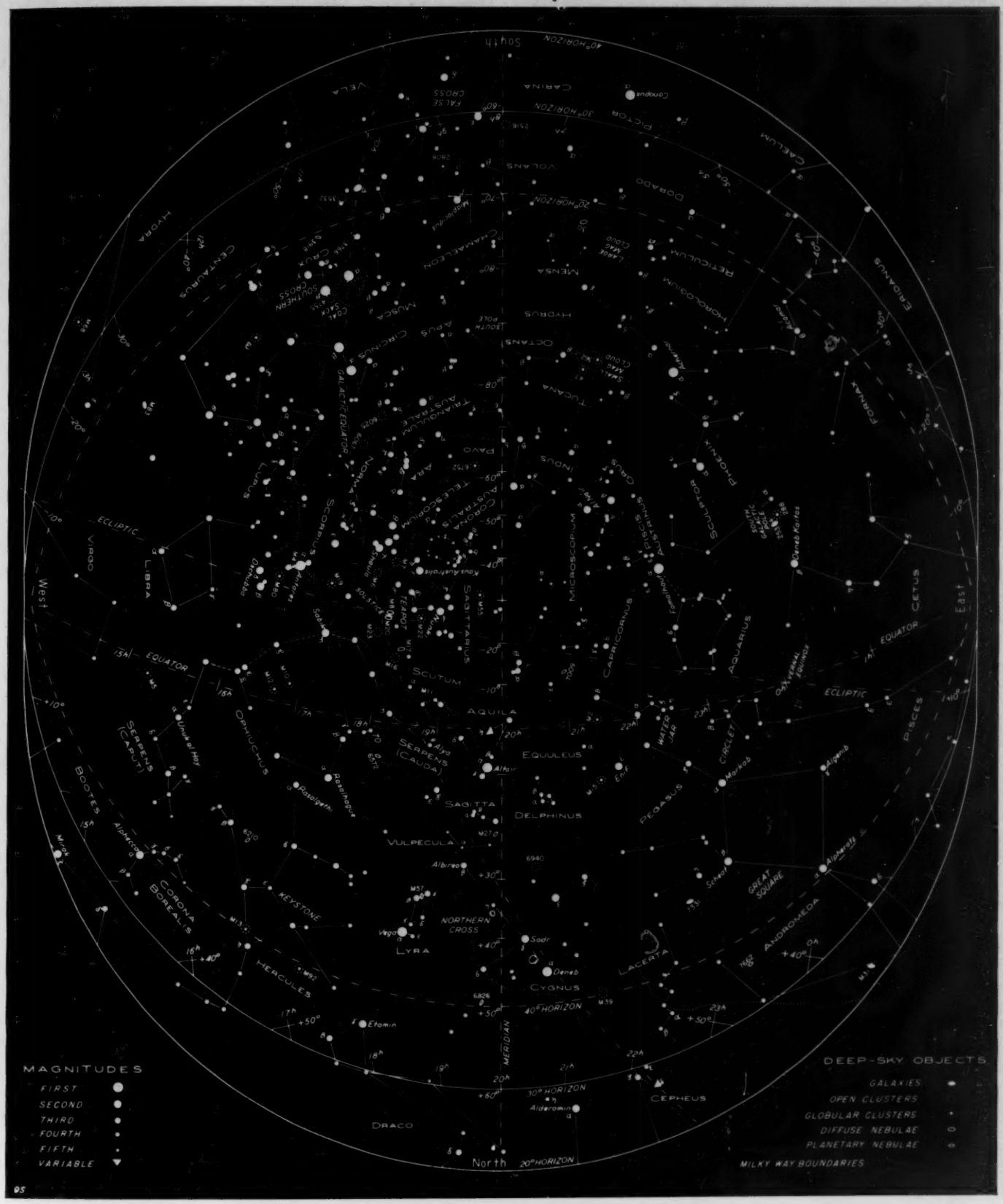
In Ursa Major, not far from Merak, is the Owl nebula, M97, a planetary measuring 199″ x 203″. NGC 3587, 11h 12m, +55° 17′. Small telescopes show a uniform disk without internal structure; the central star is visual magnitude 14.

South of Mu Hydrae is NGC 3242, 274, 10h 22m, −18° 23′, a planetary measuring 40″ x 35″. It contains a bright inner ring and a faint outer ring. Its central star is 11.3 visually, 9.0 photographically.

WALTER SCOTT HOUSTON

STARS FOR JUNE

This chart shows the sky as it is seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.



EVENING STARS FOR SOUTHERN OBSERVERS

THIS CHART is prepared for a basic latitude of 30° south, but it may be used conveniently by observers 20 degrees on either side of that parallel. These southern charts appear in alternate months, but always two or three months in advance, to allow time for transmission to observers in any part of the world. The sky is here shown as it appears on Aug. 7th at 11 p.m., Aug. 23rd at 10 p.m., Sept. 7th and 23rd at 9 p.m. and 8 p.m., respectively. Times for other days vary similarly, four minutes earlier per day. These are local mean times which must be corrected for standard time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts. For other charts in this series, see issues of alternate months from September, 1945, to July, 1946; and August, 1946, to the present.

OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

Notes on Occultations of Jupiter

DAYLIGHT will interfere with the observation of the occultation of Jupiter scheduled for the southern states on the 28th of this month. It will probably not be possible to obtain a picture like that which appeared on the cover of the March, 1947, issue of the **Griffith Observer.** By courtesy of that publication, the picture is reproduced here, together with a diagram used by Dr. C. H. Cleminshaw to illustrate an article explaining certain phenomena of occultations in general and of Jupiter in particular. Our readers may be interested in reviewing Dr. Cleminshaw's article, which follows:

The photographs show Jupiter and its satellites emerging from behind the moon on January 16, 1947. As seen from the Griffith Observatory, Jupiter disappeared behind the bright limb of the crescent moon at four o'clock in the morning and appeared again about 52 minutes later. The first of the three pictures was taken at 0450 and shows two of Jupiter's satellites already visible. The second was taken at 0454 just after the planet had cleared the moon's edge. In the original photograph a third satellite can just barely be seen at the left edge of the overexposed image of Jupiter, but is lost in the reproduction. The last picture was taken at 0503 just after the last of the four satellites appeared. These pictures were made by Paul Roques assisted by Raymond Moore.

The part of the moon which is shown is illuminated by earthshine. The earth reflects more than 50 times more sunlight than the moon does, since its surface area is larger and its reflecting power is greater. The dark area which is nearly circular and just above the center is Mare Crisium.

During 1947 there are eleven occultations of Jupiter, but only one other one will be seen in southern California, and that will occur in the daytime. Immersion will occur when the moon is below the horizon, but emersion will be seen at 1610 (4:10 p.m.) P.S.T. on June 28. With sunset coming three hours later, the moon and Jupiter will still appear quite close to each other in the evening sky. Other close approaches of Jupiter and the moon will be observable on the evenings of May 5, June 1, July 25, September 19, and October 16.

The following table lists the eleven occultations of Jupiter which occur in 1947. The limiting parallels of latitude within which each occultation is observable are marked + for north and — for south. If a place is within these limits, one of the conditions is satisfied for the observation of the occultation from that place. The other necessary conditions are too involved to be considered in this short article.

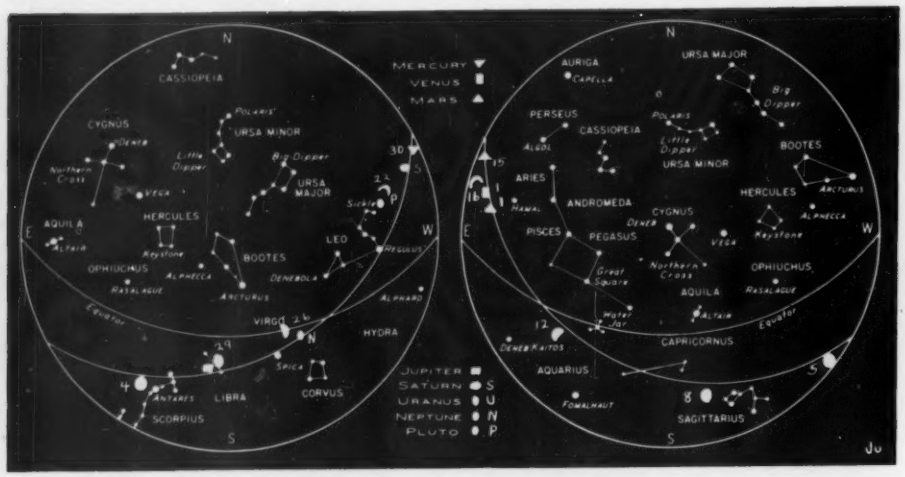
The mid-latitude given in the next column is halfway between the limiting parallels. The last column gives the number of minutes of arc which the center of the moon is north (+) or south (—) of Jupiter as they would be seen from the center of the earth. The occultations are arranged according to the amount of this angular separation.

Date	Limiting Parallels		Mid-Latitude	Angular Separation
Jan. 16	+72°	— 5°	+34°	+38′
June 28	+50	−28	+11	+15
July 25	+48	−30	+ 9	+13
Feb. 12	+33	−41	− 4	+ 1
June 1	+34	−44	− 5	− 1
Aug. 22	+29	−49	−10	− 7
May 5	+11	−70	−30	−24
March 12	+ 7	−74	−34	−27
April 8	− 2	−90	−46	−36
Sept. 19	0	−89	−45	−37
Oct. 16	−43	−89	−69	−70

An interesting relation exists between the figures in the last two columns. A change in the angular separation of 1′ results in a corresponding change in the mid-latitude of about 1°. For example, the differences in the occultations visible from Los Angeles on January 16 and June 28 are 23′ in separation and 23° in mid-latitude. This results from the fact that in round numbers the moon's distance from the earth (240,000 miles) is 60 times the earth's radius (4,000 miles).

For an occultation to occur somewhere on the earth the geocentric angular distance between the centers of the planet and of the moon at closest approach must be not more than about 78′. This figure is arrived at by adding the maximum semi-diameter of the moon (nearly 17′) to the

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 3:30 a.m. local time on the 7th of the month, and at 2:30 a.m. on the 23rd. At the left is the sky for 9:30 p.m. on the 7th and 8:30 p.m. on the 23rd. The moon is shown for certain dates by symbols which give roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury may be favorably viewed most of the month in the evening sky. Greatest elongation occurs on June 17th, when the planet is 24° 41′ east of the sun. On June 1st, Mercury is of magnitude −0.5, and 15° above the horizon at sunset. At elongation, the planet sets 1¾ hours after sunset, but it has dropped to magnitude +0.7. The planet is just south of Castor and Pollux, and somewhat brighter. It vanishes in the twilight about a week after elongation.

Venus, no longer a conspicuous object, rises about an hour before the sun. Its magnitude is −3.3, and in a telescope the disk appears almost circular.

Earth arrives at heliocentric longitude 270° at 6:19 on June 22nd, and summer commences in the Northern Hemisphere, winter in the Southern.

Mars rises from one to two hours before the sun in the morning sky, magnitude +1.6. It may be found well above Venus, but by the end of the month it is south of the Pleiades in Taurus. On the morning of June 15-16th, Mars may be seen just north of the moon.

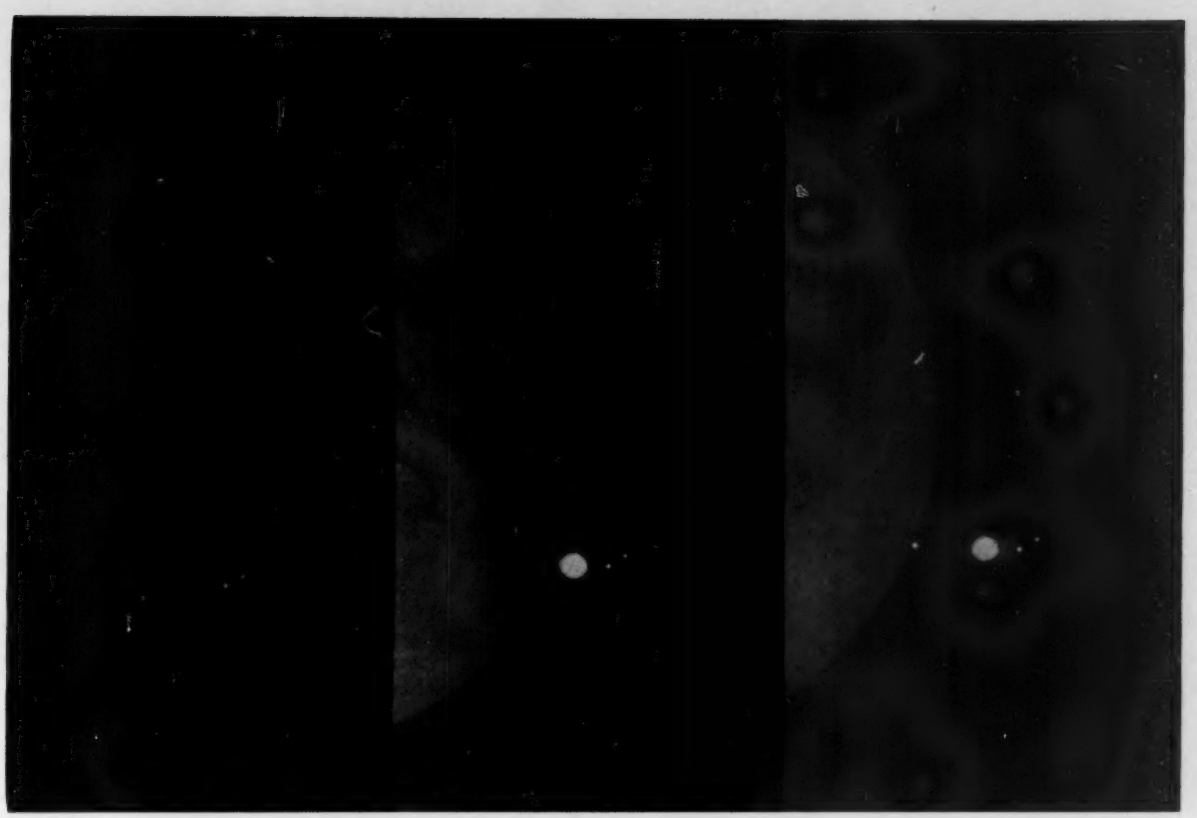
Jupiter is a brilliant object visible most of the night in the southern sky. On the nights of June 1st and 28th (see occultation predictions), the planet will be very close to the full moon. Jupiter is in Libra, retrograding, and its magnitude is −2.0.

Saturn sets several hours after the sun, and is rapidly fading from easy view. It remains in Cancer, and in mid-June passes just south of the Praesepe cluster. Mercury, Castor and Pollux are visible below Saturn shortly after sunset. For a diagram of Saturn's satellites, see the April issue.

Uranus is in conjunction with the sun on June 13th, hence the planet cannot be seen.

Neptune may be found with a small telescope near Gamma Virginis. Eastern quadrature occurs on June 30th. The planet's position on the 15th is $12^h\ 32^m$, −1° 47′.

E. O.



Three photos of Jupiter and its brightest satellites emerging from behind the moon on January 16, 1947. Mare Crisium is visible by earthshine. Photo by Paul Roques. Engraving courtesy the "Griffith Observer."

maximum horizontal parallax of the moon (a little over 61′). The latter is the maximum angle at the moon subtended by the earth's radius. Also it would be the angle at the earth subtended by a line at the moon equal in length to the earth's radius. This will now be explained with the aid of a diagram.

In the diagram, parallel lines are drawn from E, the center of the earth, and from O, D, and F, points on the earth's surface. These indicate the parallel rays of light coming from a star or a planet. The moon is indicated at two positions, M and C. The moon's shadow is a cylinder having the same diameter as the moon. With the moon at M, its shadow strikes the earth between D and F, producing an occultation of the star in that region.

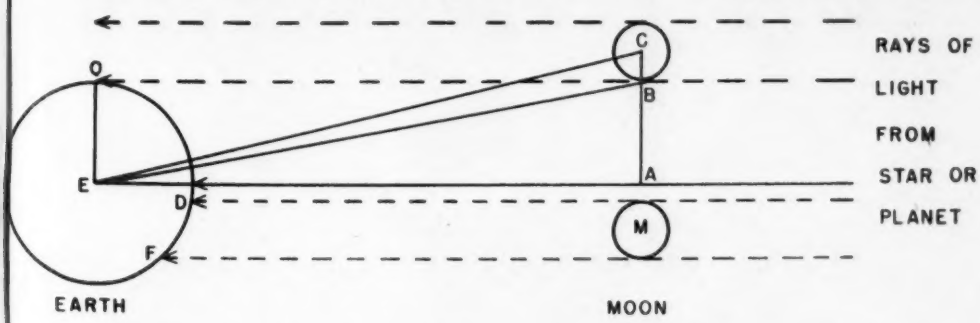
When the moon is at C, its shadow just misses the earth and no occultation can be seen at any place on the earth. The angle CEA represents the separation of the center of the moon and the star under this condition. This angle is the sum of two angles, AEB and BEC. AB is equal to OE, the earth's radius. AEB is equal to the angle subtended by the earth's radius at the distance separating the earth and the moon. This has a maximum value of 61′. BEC is the angle subtended by the moon's radius as observed from the earth. It has a maximum value of 17′. Therefore, AEC equals 78′. When the geocentric separation of the moon's center and a star or planet is more than 78′, an occultation is impossible.

Dr. G. M. Clemence, director of the Nautical Almanac Office of the U. S. Naval Observatory, points out in the **Texas Observers' Bulletin** that this limiting separation of 78′ is not the geocentric difference in declination at geocentric conjunction in right ascension unless the moon happens at that time to be moving parallel to the equator. He states that it is possible for the limiting difference in declination to reach about 90′ under extreme circumstances. The first conjunction of Jupiter in 1947 which is not an occultation occurs on November 13, when the difference in declination is 101′.

In the table of occultations of Jupiter, the range of latitude over which each occultation is visible is nearly the same, except in the last case. For example, on January 16 the limiting parallels were +72° and −5°, giving a difference of latitude of 77°. The figures for June 28 of +50° and −28° give a result of 78°. There are three other ranges of 78°, one of 74°, and two of 81°. The others are 88°, 89°, and 46°.

A glance at the diagram will show that the difference in latitude of D and F, the edges of the moon's shadow on the earth, will be less than the values just given. When the center of the moon is at A, on the line from E to the star, D and F will be about 30° apart. The moon's shadow on the earth will have a diameter of about 2,000 miles. Since there are 69 miles to the degree, that will correspond to about 30°. Incidentally, the area of the earth's surface in the moon's shadow at any instant under these conditions is approximately equal to the area of the United States (about 3,000,000 square miles).

As the moon's shadow is shifted away from the line EA, the width of it on the earth's surface increases and reaches a maximum of about 60°. However, even this value is smaller than those given in the table. The explanation lies in the fact that during an occultation the moon's shadow moves across the earth's surface in a direction which is not exactly east. It has a northerly or southerly component which may make the path of the shadow inclined as much as 30° away from east. The maximum difference of latitude between the limiting parallels which could be found in the list of 1947 occultations is 95°.



Conditions for the occultation of a star or planet by the moon. This diagram was drawn by Dr. Cleminshaw to illustrate the article which is reprinted here.

NEWS OF COMETS

The brightness of Comet Rondanina-Bester, discovered late in March in the Southern Hemisphere, increased more rapidly than expected. According to observer Johnson, at Johannesburg, the magnitude rose from 9.5 on March 28th to 8.5 on April 3rd, and to 6.0 on April 13th. In the following ephemeris computed by Dr. L. E. Cunningham, Students' Observatory, University of California, Berkeley,

it has been assumed that the brightness will vary inversely as the fourth power of the distance from the sun. It is possible that the comet may become brighter than these predicted magnitudes. Perihelion passage, at about 0.56 astronomical units from the sun, occurs about May 21st. The comet thereafter recedes from both the earth and the sun, but assumes a more favorable position in the sky for Northern Hemisphere observers. It must be carefully watched for before sunrise, as even on June 16th, when its declination is slightly less than the sun's, it is only 2½ hours of right ascension west of the sun.

Date	h m	° ′	Mag.
May 23.0	2 21.9	−2 29	5.3
27.0	2 26.1	+2 05	5.6
31.0	2 31.5	+6 26	5.9
June 4.0	2 37.8	+10 31	6.3
8.0	2 44.9	+14 20	6.8
16.0	3 00.4	+21 10	7.6
24.0	3 16.8	+27 01	8.4
July 2.0	3 33.3	+32 03	9.0
10.0	3 49.5	+36 28	9.7
18.0	4 05.1	+40 23	10.2
26.0	4 19.9	+43 54	10.7

Comet Grigg-Skjellerup was expected to fade to magnitude 12.1 by May 31st, becoming 13th and 14th magnitude during June. Its ephemeris through October, when it may be 21st magnitude, is given on Harvard Announcement Card 806.

Comet Becvar, discovered late in March, increased its distance from the earth and its brightness decreased throughout April and May. Its probable magnitude on May 19th was 11.8, when its predicted position was $6^h\ 02^m.5$, −12° 26′, moving southward into an unfavorable position for further observation by northern observers.

Other comets now under observation by professional astronomers are all practically too faint for amateur instruments of moderate size. Those who wish to follow comets should send one dollar to Harvard College Observatory, Cambridge 38, Mass., which pays for 25 mailings of Harvard Announcement Cards, on which current news of comets, asteroids, novae, and other celestial events are carried. Cards are mailed individually to each subscriber to this service.

VARIABLE STAR MAXIMA

June 6, X Monocerotis, 7.6, 065208; 11, R Leonis, 5.9, 094211; 13, R Aquilae, 6.3, 190108; 21, T Hydrae, 7.7, 085008; 21, Chi Cygni, 5.3, 194632; 22, S Pavonis, 7.3, 194659; 29, R Aquarii, 233815. July 7, U Herculis, 7.6, 162119.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

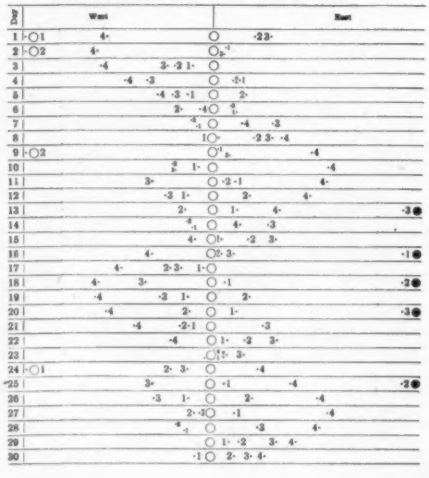
PHASES OF THE MOON

Full moon	June 3, 19:27
Last quarter	June 11, 22:58
New moon	June 18, 21:26
First quarter	June 25, 12:25
Full moon	July 3, 10:38

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the GCT given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. Reproduced from the **American Ephemeris and Nautical Almanac.**

Configurations at 4h 30m for an Inverting Telescope



OCCULTATIONS FOR JUNE

June 22-23 **42 Leonis** 6.1, 10:19.0 +15-14.6, 4, Im: **F** 5:23.0 +0.3 −1.2 111; **G** 4.54.8 −0.3 −1.5 92; **H** 5:16.3 −0.2 −1.6 118.

28-29 **JUPITER** −1.9, 15:03.9 −16-13.8, 10, Im: **F** 23:14.9 −0.9 +0.6 102. Em: **F** 0:22.0 −0.6 −1.0 325; **H** 0:09.4 −0.2 −0.1 309.

28-29 **26 Librae** 6.3, 15:11.6 −17-34.3, 10, Im: **D** 5:41.5 −1.1 −1.6 103; **E** 5:31.9 −1.6 −1.5 109; **F** 5:36.4 −1.9 −1.9 128; **G** 4:41.9 −1.5 −0.5 114; **H** 4:45.8 −1.5 −1.5 144.

29-30 **10 G Scorpii** 5.9, 15:54.6 −20-49.9, 11, Im: **A** 1:31.7 −2.5 +0.7 79; **B** 1:31.5 −2.5 +0.9 79; **C** 1:18.6 −2.2 +0.5 95; **E** 0:56.2 −1.1 +0.3 116; **F** 0:56.1 −0.1 −1.5 157.

Limiting parallels of latitude for the Jupiter occultation of June 28-29th are given in the **American Ephemeris** as +50° and −28°. This occultation should be watched for with telescopic aid by all observers in the southern United States, although it will occur in the daytime. The satellites of Jupiter will all be to the east of the planet, so they will be be occulted after the planet at immersion, and will reappear after Jupiter does at emersion. Immersion is not given for Station **H**, as it occurs below the horizon.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, GCT, **a** and **b** quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +30°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo** — **LoS**), and multiply **b** by the difference in latitude (**L** — **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

For additional occultations consult the **American Ephemeris and Nautical Almanac** and the British **Nautical Almanac**, from which these predictions are taken. Texas predictions were computed by E. W. Woolard and Paul Herget.

MINIMA OF ALGOL

June 3, 11:58; 6, 08:47; 9, 05:36; 12, 02:24; 14, 23:13; 17, 20:02; 20, 16:51; 23, 13:39; 26, 10:28; 29, 07:17. July 2, 04:05; 5, 00:54.

GREENWICH CIVIL TIME (GCT)

TIMES used on the Observer's Page are Greenwich civil or universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the GCT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

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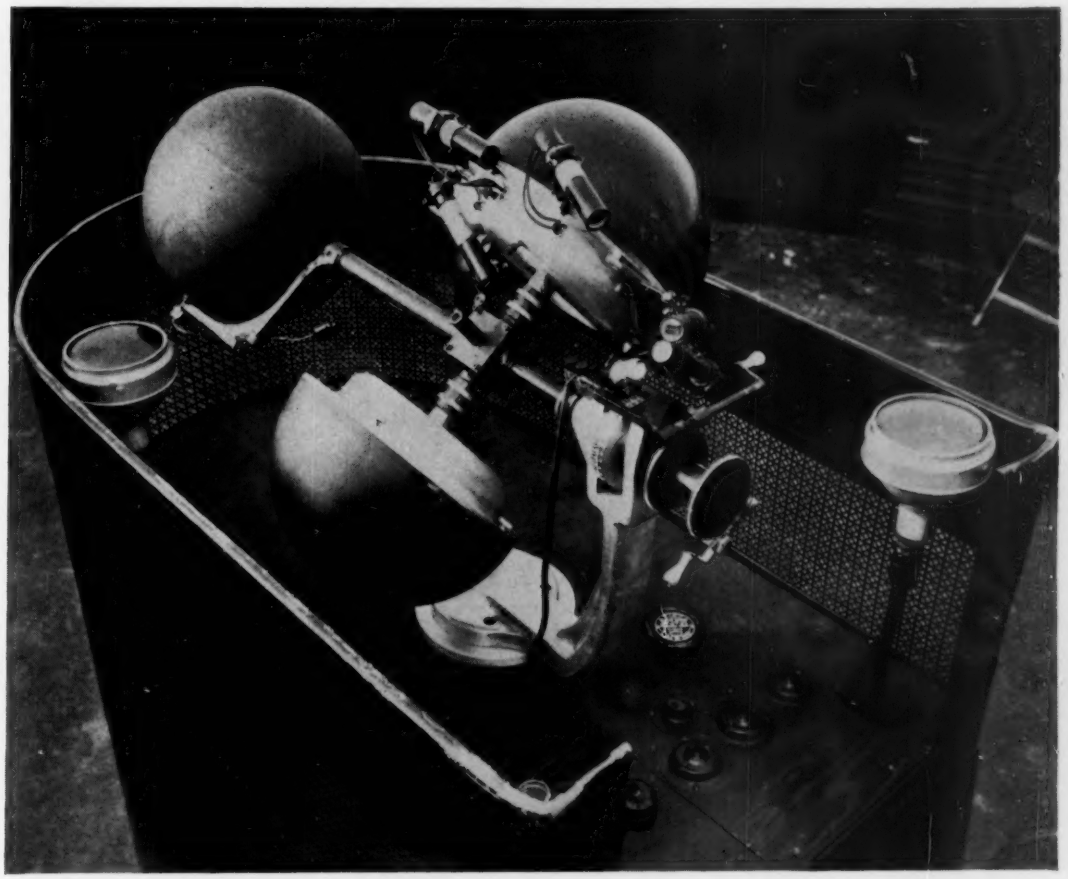

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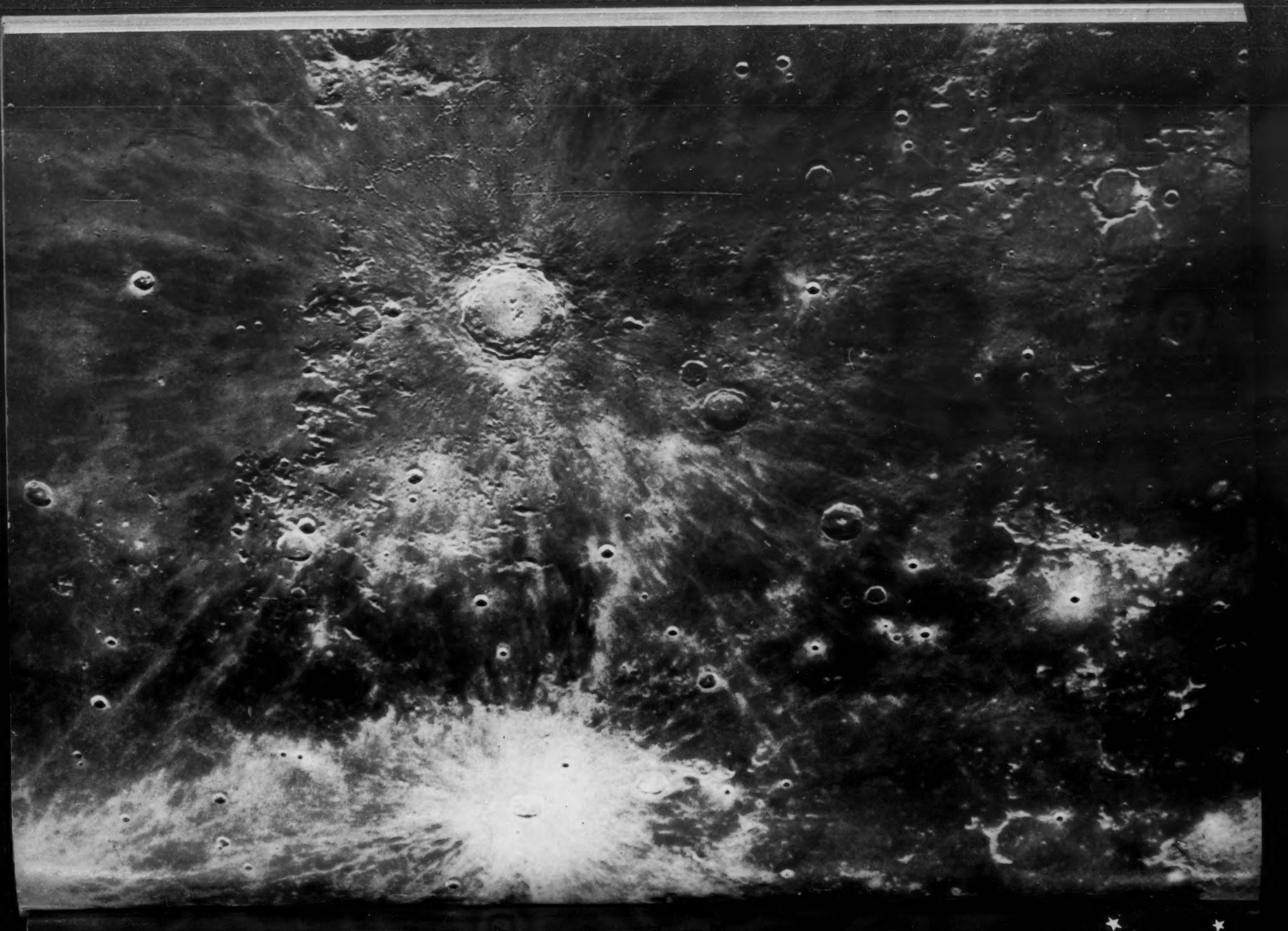
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